UNIVERSITY OF TORONTO
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A FIELD BOOK

FOR ENGINEERS MINING SURVEYORS AND CONTRACTORS.

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THE

ENGINEER'S, MINING SURVEYOR'S AND CONTRACTOR'S FIELD-BOOK.

BY

W. DAVIS HASKOLL,

CIVIL ENGINEER.

SECOND EDITION, MUCH ENLARGED.

CONSISTING OF

A SERIES OF TABLES, WITH RULES,
EXPLANATIONS OF SYSTEMS, AND USE OF THEODOLITE FOR
TRAVERSE SURVEYING
AND PLOTTING THE WORK WITH MINUTE ACCURACY
BY MEANS OF STRAIGHT EDGE AND SET SQUARE ONLY;
LEVELLING WITH THE THEODOLITE,
CASTING OUT AND REDUCING LEVELS TO DATUM,
AND PLOTTING SECTIONS IN THE ORDINARY MANNER;
SETTING OUT CURVES WITH THE THEODOLITE
BY TANGENTIAL ANGLES AND MULTIPLES
WITH RIGHT AND LEFT-HAND READINGS OF THE INSTRUMENT;
SETTING OUT CURVES WITHOUT THEODOLITE
ON THE SYSTEM OF TANGENTIAL ANGLES BY SETS OF
TANGENTS AND OFFSETS; AND
EARTHWORK TABLES TO 80 FEET DEEP
CALCULATED FOR EVERY 6 INCHES IN DEPTH.

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SCHOOL OF PRACTICAL SCIENCE TORONTO

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NEW-STREET SQUARE

PREFACE

TO

THE SECOND EDITION.

SINCE the First Edition of the 'Field Book,' the author has found, through conversation with numerous friends, that it would be advisable to enter more into detail as to the application of the Tables. He has therefore given, in the Introduction to this Second Edition, an explanation of the system of levelling with the theodolite, by which the student may perceive how rapidly a network of trial levels may be obtained over a very extensive area through a hilly country; and also of the system of traverse surveying and plotting, more particularly as applicable to the working surveys required through thickly populated districts, where great accuracy in the plans is necessary.

For those who object to the theodolite, a set of tables has been given for *setting out curves by numerous offsets from one tangent.* The author has besides added, in this Second Edition, *Earthwork Tables for every* 6 *inches up to* 80 *feet deep*; and a *Table of Gradients*, which will be found to reduce very considerably the labour of preparing working sections.

INTRODUCTION.

It is not unworthy of remark that, whilst every branch of engineering, with two exceptions, has, during the last thirty years, been progressing with 'giant strides,' the exceptions, land surveying and levelling, remain exactly where they were; this, of course, is the general rule only: there are exceptions, no doubt, numerous. Taking into consideration the great advantages of the present day, in the shape of ordnance maps, tithe plans, improved instruments, and the gradients and curves which we may now adopt, it is doubtful whether, generally speaking, surveyors know as well now how to pick out a line of railway as the professional man of a quarter of a century ago. This was about the only reproof made against the engineer by Lord Redesdale in his late 'raid' on railway people generally. His lordship observed that railway plans were not sufficiently studied; the observation is not a whit more flattering to the writer than to his brother professionals, but he submits that it is true.

It would, of course, be unfair to apply this observation to those cases where a professional man is sent down at the very last moment, when there is scarcely time to prepare any plans and sections whatever, after merely giving a glance at a country, where he can very often barely see a mile ahead. The condition now more particularly referred to, is where the engineering surveyor is engaged in actual exploring or trial levelling for the selection of a line of railway at home or abroad, and as to the most expeditious method of obtaining sufficient levels to ensure the best passes, the most favourable starting-points when we are at liberty to select, and the best points or thereabouts along the line so as to avoid heavy works. These circumstances necessitate getting over a wide expanse of ground in a short time, and this can be done only by adopting suitable means.

The 'good old times' have passed away, when we laid out railways through flat and undulating countries; with very few exceptions, these territories are all fully occupied, and the engineering surveyor, in projecting lines of railways at the present time, must make up his mind to wind along hills and over mountains. Not only the ground is broken in every direction by chains of lofty hills, but out of these run numerous spurs and valleys which require close study before anything like a good line can be laid out amongst them, even after a particular general route of country has been determined on as the best, purely from an engineering point of view. In such districts as are now referred to, the hills very commonly rise and fall 50 and 100 feet within very short distances, such as 100 or 150 yards; not only is it necessary to have levels over such ground, so as to avoid as much as possible very heavy works, but the pass has often, and indeed most generally, to be kept in view, whether it be very high or very low ground; and not only the ground rises and falls in numerous places at the rate above mentioned, for distances of 100 and 150 yards, but often also at the same rate for ten times such distances.

Again, before the general route above referred to can be determined upon, the country for a mile or two right and left, and often much more, requires examination, not merely by the eye, which in really hilly countries is very likely to deceive, but by some rapid instrumental exploration; and it is only when this has been done that the best line generally can be discovered. The work more particularly referred to now, is railway work at home, where we have often a severe parliamentary ordeal to go through; this we observe advisedly, for unless we have opposition, it matters very little, except as regards expense, what kind of a line is brought forward.

Notwithstanding all these difficulties, however, which have sprung up naturally, and simply from our having to project our works under circumstances generally so very different to those of twenty and thirty years ago, we adhere, with only a few exceptions, to exactly the same instruments, and the same mode of using them as we did then. The reserve, however, of a few exceptions has been made, because there are engineering surveyors who have adopted a totally different method of going to work, and mostly they are well and profitably employed; but in subjects of this kind we cannot refer to exceptions, and we can only deal with the general state of things as we meet with them.

The only instrument still generally employed for getting explore levels, even over the most hilly country, is only and simply the level in its ordinary form; and, however expert the observer may be, he will not get over a hundred feet rise in much less than six observations: with the theodolite this is done at one sight, that is, with five-sixths less trouble and time. The ordinary mode of using the level for trial levelling, is to begin at some particular point, and to wind up and down with instrument and staff along the sidelying ground proposed to be adopted, and so get a few levels right and left, these being referred to in the level book, and on a plan by letters or numbers. One trial line having been got over, another line is tried in the same manner; but, from the nature of the instrument in its simple form, the work is slow, and in hilly countries confined to very narrow limits.

Two or three instances which have occurred within the author's experience, will perhaps tend to explain the different results that are to be obtained from trial levelling with the theodolite, and with the level in its ordinary form.

It is now some years since, that a line of railway was laid out, and even stumped out, through a mountainous country, and the construction of which would have involved about 2½ miles of tunnel through a very hard rock, containing large quantities of water; this was independent of very heavy cuttings and some lofty viaducts. The works altogether were so expensive that some thoughts were entertained of abandoning the whole concern as not likely to pay. Let it be distinctly understood that the men who had laid out this line were thoroughly able and experienced, but the only instrument they had used was the level; for some six or seven miles of approach to the tunnel, they were confined in the gorges of hills rising some four or five hundred feet on each side, and they could not get out of them.

Under the circumstances above mentioned, a new order of things was established, and the theodolite was brought into operation for trial levelling. In about three weeks a new line was found; two short tunnels were substituted for the long one above referred to, with practicable works of approach.

On another occasion, of much later occurrence, after about six weeks' trial levelling, with the level, by a gentleman of first-class experience and abilities, plans and sections were deposited for a short line, which showed two tunnels, one of which was upwards of a mile and a half in length, with very long and heavy embankments on each side, one of which, for a considerable length, was 80 and 90 feet deep. The deposit was made, but no further motion was taken in the matter; and not only this, but a line between the two places was given up as impracticable. Under this state of things the subject was taken up by another engineer; he trial levelled for a line between the two same places, but with the theodolite, and in a short time he obtained so many levels over an extensive area, and over totally different ground, that he obtained a line with only a quarter of a mile of tunnelling, all other works being of quite an ordinary character.

The writer will mention one more instance to show how easily the eye, even of a well-practised man, may be deceived in the matter of levels in a hilly country. A professional man of extensive practice had been told that in a particular place, through which he was running a line, he would there have a tunnel; but he was quite satisfied, from what he could see, that he should only have some 40 feet of cutting. When, however, the deposit was made, the section showed 300 yards of tunnelling, with a depth of 110 feet.

The above instances have only been given to demonstrate practically to those who are not in the habit of using the theodolite for taking trial levels, that the practical application of the instrument for this particular purpose has led to most important results; and it was only because the writer had had most satisfactory experience on the subject, that he calculated the tables given in this volume, and which are equally applicable to the best and most accurate style of surveying, that is, surveying by traverse. This in no way refers to *Parliamentary* work.

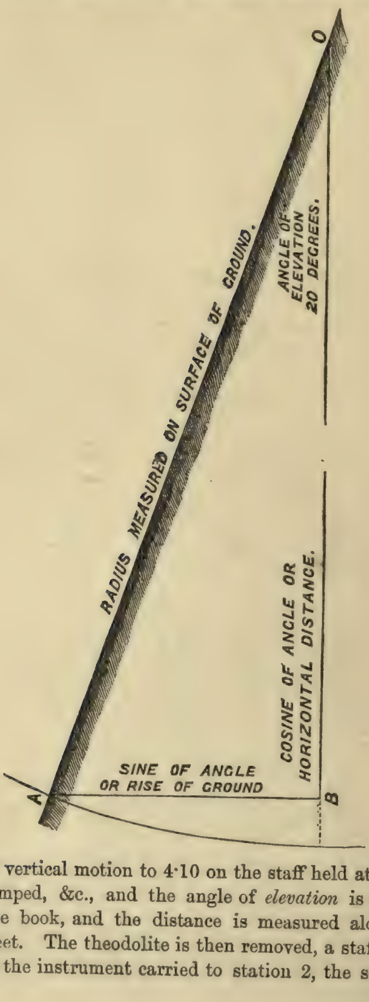
As regards these tables and theodolite levelling, it is now about two years and a half ago that he had occasion to take some levels through a valley amongst the chalk hills in the south of England; besides the main line there were 37 cross-sections, each of which was about half a mile long, each falling from 350 to 500 feet, and then rising 500 and 600 feet on the other side; in a week, thanks to the theodolite, the work was accomplished, and, with the assistance of the tables, then in manuscript, it was very rapidly cast out, reduced and plotted, just in the same way as in the ordinary level book, angles of depression and elevation being taken, instead of heights in feet, for back and foresights.

To the practised engineer, it must, of course, be needless to explain the manner in which the levels for a section are taken with the theodolite; but the writer having met with many who really had no idea about it, he will not apologise for now giving a full explanation, the more so that such matter is always useful to students, and will in all probability become more so at some future time, when theodolite levelling will become common practice.

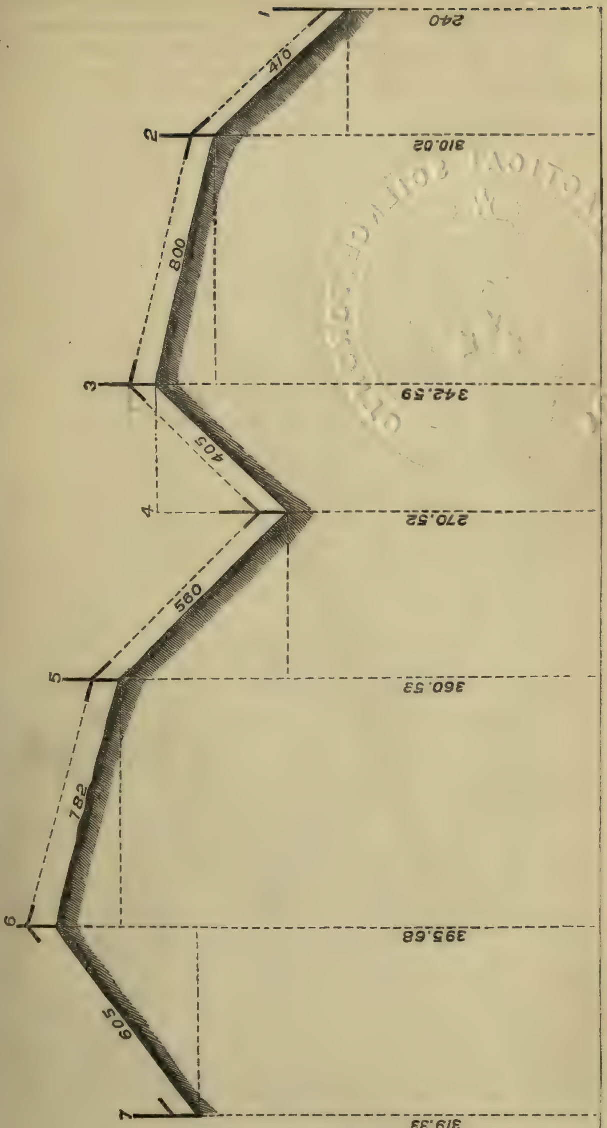
LEVELLING WITH THE THEODOLITE. — CASTING-OUT LEVELS AND REDUCING BY THE USE OF THE TABLES.—PLOTTING SECTION.

Let A O B be an angle of elevation of 20 degrees, measured with the theodolite placed at O, whilst a staff has been held at A; and let the distance from O to A measure 100 feet. O A = 100 feet is only the length measured along the surface of the *sloping* ground; B O is the true horizontal distance, and B O is the cosine of the angle of elevation; and A B is the difference of level = to the sine of the angle of elevation. By means of the tables we get the lengths of both these required lines. At page 64, we find that for the angle of 20 degrees, and for the measured length 100, the horizontal distance for difference of levels is 93·969; this will be equal to B O; and at page 65 we find that the difference of levels for this angle of 20, and measured length of 100 feet, is 34·20; this will be equal to A B, and will give the rise, or height of A above O.

We will now apply this to the diagram of a section, p. ix.; 1, 2, 3, 4, 5, 6, are the stations for placing first the levelling staves, and then the theodolite; for instance, the level of the ground at station 1 having been previously ascertained, the staff was held at station 2, and the theodolite set up at station 1, paying proper attention, of course, to the verniers of the vertical limb and to the bubbles. The centre of the instrument is found to be 4·10 feet above the ground; then the telescope


O
ANGLE OF ELEVATION 20 DEGREES.
RADIUS MEASURED ON SURFACE OF GROUND.
COSINE OF ANGLE OR HORIZONTAL DISTANCE.
SINE OF ANGLE OR RISE OF GROUND
A
B

is directed by vertical motion to 4·10 on the staff held at station 2; the vernier is clamped, &c., and the angle of *elevation* is read off, 9° 50′ entered in the book, and the distance is measured along the sloping ground, 410 feet. The theodolite is then removed, a staff left behind at station 1, and the instrument carried to station 2, the staff from which


1
240
410
2
310.02
800
3
342.59
405
4
270.52
560
5
360.53
782
6
395.68
605
7
319.33

is sent forward to station 3; the theodolite is then properly set up over station 2; the height of the instrument above the ground is now found to be 5·1 feet; then the telescope is directed to 5·1 on the staff held at station 1, and the angle of *depression* on the vertical limb should be found to read exactly 80° 10′=90°−9° 50′. The telescope is now turned to the staff at 3, the angle of *elevation* read off, entered in the book, and the distance from station 2 to station 3, equal to 800 feet, is measured and also entered. The instrument is then removed from station 2, some peg or mark being left there, in order that the staff-holder coming forward from station 1 may find the exact spot. The instrument is now carried forward to station 3, and properly set up as before; the staff from station 1 being now held at station 2, and the centre of the instrument being 4·15 feet above the ground, the telescope is directed to 4·15 on the staff at 1, and the angle of *depression* is read off and entered. The telescope is now turned to the staff held at 4, and directed to 4·15 (the height of the instrument above the ground); the vernier is again clamped, &c., &c.; the angle of *depression* is read off from the limb, and entered in the book, and the distance, 405 feet, measured along the ground, entered also.

The theodolite is now removed to station 4, whilst the staff is brought forward from station 2 to station 3, and the other staff is carried forward to station 5; the instrument being now placed at station 4, we take the angle of *elevation* on to the staff held at station 3, and then the angle of *elevation* to the staff held at station 5, exactly in the manner already explained, and we progress in this manner to the end of the line.

Let us now refer to the field-book in which the observations are recorded.

Back Angle	Fore Angle	Rise	Fall	Measured Lengths	Reduced Levels	Total Reduced Dist.	Reduced Lengths
						Feet.	
					240·00	5000	
	9 – 50 E	70·02		410	310·02	5405	405
80 – 10 D	2 – 20 E	32·57		800	342·59	6204	799
87 – 40 D	10 – 15 D		72·07	405	270·52	6602	398
79 – 45 E	9 – 15 E	90·01		560	360·53	7155	553
80 – 45 D	2 – 35 E	35·15		782	395·68	7934	781
87 – 25 D	7 – 15 D		76·35	605	319·33	8534	600
83 – 45 E							

It will be observed that the back angle is a complete check upon the whole of the field-work.

The rise and fall are obtained from the tables of 'Differences of

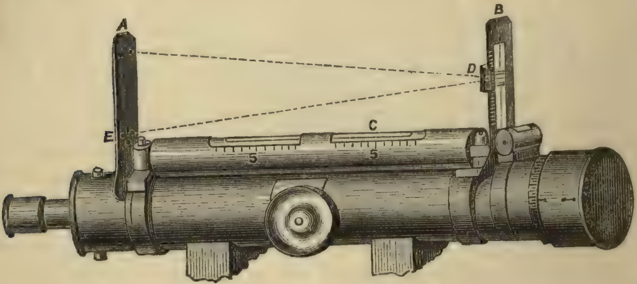
Levels,' and the reduced lengths from 'Horizontal Distances for Differences of Levels,' merely by removing the decimal point to the right or left.

The levels having been cast out, and reduced in the ordinary manner, and the *reduced* lengths added up in the column 'Total Reduced Distance,' the section is plotted in the usual manner.

It will be observed that in the diagram explanatory of the mode of plotting the levels, only the leading points have been noticed on the section: small inequalities are quite secondary considerations in taking trial levels over a hilly country, but there is nothing to prevent intermediate depressions in the ground being noticed on the flypage.

It will also be observed, that besides the angles of depression and elevation taken along the main line, we may also take observations right and left, the levels so obtained being quite as valuable for our purposes as those obtained from the main line. It is indeed the great facility with which these side levels are obtained by the means of theodolite levelling which makes the system so valuable; from the rapidity with which the work is done, a difference of 200 or 300 feet in levels, or much more, being obtained at one sight, quite as easily as 8 or 10 feet with the ordinary level; and when the instrument is supplied with a micrometer, the *distances* are read off rapidly, quite near enough to all intents and purposes, without chaining. In the diagram and example of field-book given here, no reference is made to *side* levelling, in order that there may be no confusion in the elementary explanation of *elevation* and *depression*, and the corresponding *rise* and *fall*, and *reduced* distance. After what has been just said, it cannot fail to be observed, that for obtaining levels over the ridges enclosing large areas of watershed, the system is very rapid, and equally valuable for taking cross sections in very sidelying ground, in matters of deviations. It is by these means that a great number of levels above a given datum are written in on maps or plans; and as regards railway engineering, there then remains but little to do in determining the direction of a line, in ascertaining pretty accurately the nature and extent of the works, as well as the gradients and curves to be adopted. With such documents at hand, it is easy to avoid sending in ill-studied plans and sections.

But very few engineers, if any, were better acquainted with all the details of engineering field-work than the late Mr. Gravatt; and he was perfectly aware that, even in his working-days, the level by itself was very limited in its capabilities for trial levels, and to increase its usefulness, for the purpose of trial levelling and cross sections particularly, he added the appliances shown in the accompanying diagram, in which it will be seen that A and B are two plain sights, which are so contrived that they are shipped and unshipped with the greatest ease; A has a vertical slit and two horizontal ones; B has a fixed vertical horsehair, and is also provided with a *slide*, D, carrying a cross-hair, which intersects the vertical horsehair higher or lower, according as the slide is moved up or down. The slide D is also provided with a vernier on each side of the broad arrow ⟶, by which the divisions engraved along B are subdivided into tenths and hundredths. The dotted line, DE, shows that this contrivance affords a most ready means of obtaining the rates of inclination of any sidelying ground, or, as will be presently seen, any difference of level. The depth between the horizontal slits of A is made exactly equal to the *whole* of the divisions on B, which whole is made by the maker exactly equal to some decimal fraction of the horizontal distance between A and B, which in the instrument before us measures exactly 10 inches. The *whole* of the divisions of B is equal to 2 inches, or $\frac{1}{5}$ of the distance AB; one half, therefore, of the divisions is equal to 1 inch, or $\frac{1}{10}$ of the distance AB; and as this inch, or $\frac{1}{10}$ of AB, is divided into 10 equal parts, each subdivision is equal to $\frac{1}{100}$ of AB: two subdivisions will be $\frac{2}{100}$, and three will be $\frac{3}{100}$, and twenty will be $\frac{20}{100}$; and these hundredths will give the rise or fall per hundred (any unit of measurement) *horizontal*.



The instrument is used in the following manner. When an observation is required to be taken, a staff-holder is sent on to the given spot; if an *elevation* is to be taken, the observer applies the eye to the *lower* horizontal slit, and the cross-hair of the slide D is made to coincide with that reading on the staff which is equal to the height of the instrument above the ground; there only remains to take off the reading. In the diagram, the cross-hair intersects *above* the 12th division, and by means of the vernier (the divisions of which are too small to be shown in the figure), we find the *subdivision* to be ·53; then the whole reading will be 12·53, which means at once that the ground rises at the rate of 12·53 per hundred *horizontal*—as, for example, 12·53 feet per *hundred* feet *horizontal*.

If an angle of *depression* is to be taken, the eye is of course applied to the *upper* horizontal slit. In the figure before us, with the slide still at D, we find the arrow intersects a little below 7 subdivisions, and the excess we read off by the vernier (the upper side of the arrow) to be ·47; the reading will therefore be 7·43, which means that the ground falls 7·43 feet per *hundred* feet *horizontal.*

Now, we have observed above, that 'the cross-hair of the slide is made to coincide with that *reading on the staff* which is equal to the height of the instrument above the ground.' It may be added that, for all ordinary purposes, it is unnecessary to use a levelling-staff; it will be generally sufficient to send a man to the required spot, where he may hold up a piece of white paper at the height of his neck, or thereabouts, according as the instrument is higher or lower above the ground. For short distances, this will answer all practical purposes, where rapidity is more requisite than extreme accuracy of fractions of feet.

An approximate level may, however, often be required for some considerable distance. For instance, let us suppose that an elevation has been read off of 27·47, and that the distance, *measured along the sloping* ground, is 460 feet; required the total rise, and the horizontal distance from the observer to the point observed. Refer to Table I., and under the column 'Rise or Fall per Hundred Horizontal,' look for the given reading 27·47, or the nearest to it; we find this, or 27·42, at page 15, and it coincides with the angle of 15° 20′; now look for this angle in Table II., where we shall find it at pages 54 and 55; the angle of 15° 20′ gives for 400 feet, difference of level, 105·77

and for 60 feet „ „ 15·86

Total rise or difference of level = 121·63

Similarly we find the horizontal distance:

For 400 feet, horizontal distance, 385·76

For 60 „ „ „ 57·86

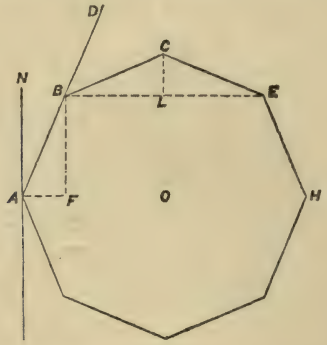
Total *horizontal distance* from instrument to observed point = 443·62

In this instrument of Mr. Gravatt's, as made by Archbutt and Sons, the plain sights also enable an observer to take a bearing, or horizontal angle, with considerable accuracy, whilst the divisions on the cap or sunshade will enable him to take approximate angles of elevation or depression, which will often be found exceedingly useful.

To the young practitioner and student, and to those generally who have never taken levels by any of the means here mentioned, it may be as well to make a few observations as regards the above example. The rise per hundred feet horizontal we find to be 27·42, and the measured distance along the slope is 460 feet; if 27·42 had been multiplied by 4·60, we should have had 126·13 for difference of level, or an error of about 5 feet. This is mentioned to make it perfectly intelligible that the readings we get on the scale, are the ratios of rise or fall per hundred feet horizontal; in the next place we may add, that of course, in taking the observations, it is necessary that the bubble should be exactly in the centre of its run, in the same way as though the observer were taking ordinary levels.

THE ELEMENTS AND PRACTICE OF TRAVERSE SURVEYING.

The correct practical principle of working a traverse on the ground consists of the best method of reading the angles round any regular or irregular polygon, and measuring the lengths of the sides. From these angles and lengths certain calculations are made, which enable us, with no other instruments than a straight-edge and set-square, to lay the work down on paper with *any* degree of precision. Table II. gives these calculations all ready to the surveyor's hand.



Let A O E be a regular octagon, which we propose going round with the theodolite, starting from A. Let A N be the magnetic north; zero on the horizontal limb is made to coincide exactly with the needle;* in the next place, the angle N A B is taken, which will here be 22°–30′; 90°–22° 30′=67° 30′=the angle B A F, to which B F is the sine, or departure, and A F the cosine, or latitude, given in Table II., as already fully explained above. Now, in the regular octagon, each of the angles at the circumference, that is, A B C, B C E, C E H, is equal to 135 degrees.

The intersecting angles at B, =360°, are made up of A B D, =180°,

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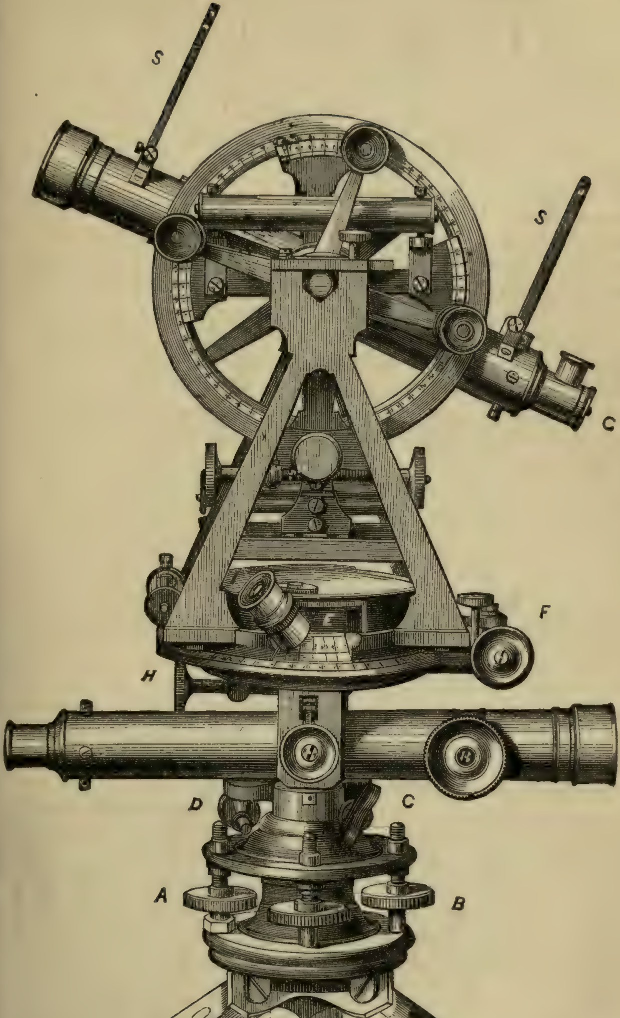
* In Mr. Hoskold's Transit Theodolite, constructed by Messrs. Archbutt, the compass is nearly twice the ordinary size, and quite free and open, so that it can be read very accurately.


S
S
C
F
H
D
C
A
B

plus A B C, = 135°, and D B C, which will be equal to 45°. It will be the same thing, of course, at C, E, &c., as in the regular octagon given the angles at the circumference are all equal to each other.

We will now return to the theodolite, which we have left all clamped, and reading 22° – 20′. The length A B being measured, the instrument is to be removed to station B, and there set up exactly over the point B, which is done by the shifting of the legs, so as to make the plumb-bob hang exactly over the right point. The next adjustment is to bring the bubbles exactly to the centres of their runs; this places the instrument in *horizontal* adjustment, so that the angles taken shall all be horizontal. This is effected by means of the parallel plate screws, two of which are shown in the figure at A and B. The instrument being correctly placed at B, we have now to bring the reading 22° – 30′ to bear exactly on point A, where, of course, a pole is held up, care, however, being taken that the intersection of the wires of the diaphragm shall be exactly on the foot of the pole, whilst the vernier, as last fixed on the limb, remains perfectly untouched.

To do this, the clamp C is slackened, which allows the whole of the instrument to be turned round bodily on its axis, without any portion of the upper part of the instrument being moved in the least degree. The theodolite is now to be turned round, whilst the observer looks along the upper telescope, which he directs towards A, or through the plain sights S, S; when the intersection of the wires of the diaphragm* (which, for the sake of brevity, we shall in future call the sight) pretty nearly coincides with the station A, the clamp C is tightened, and the contact of the perfected sight with the foot of the pole at A, by means of the tangent-screw D, which allows of the most delicate and regular horizontal motion of the instrument.

This perfect contact being effected, we now release the verniers, which are shown at E, by slackening the upper clamping-screw F; the telescope is now turned round to station C, and when the sight is nearly in contact with the foot of the pole, screw F is tightened, and, by means of the tangent-screw, the contact of the sight is perfected. We can now take off the reading of the vernier on the limb, reading with perfect accuracy by means of the magnifier I. The magnifiers in this instrument are, by a particular contrivance, made to move with the greatest possible convenience, which is a most important thing in getting an accurate reading on the limb. In the present instance, the reading will be 247° – 30′. The length of B C, being measured, the instrument is now removed to station C, with the reading on the limb (247° – 30′) left untouched.

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* In order to see the wires of the diaphragm clearly and comfortably, it is necessary to draw out the eye-piece G very gradually, until the wires appear sharp and well defined. This must be done delicately, as even the sixteenth of an inch backwards or forwards makes a great deal of difference.

The theodolite being now set up at C, in the same manner as at A and B, the clamp-screw C is slackened, the upper telescope is turned on to pole left at B, clamp-screw C is then tightened, and perfect sight completed by means of tangent-screw D. Now release clamp-screw F, turn the telescope on to E, tighten F, and complete the contact of sight by means of tangent-screw H. The reading on the limb will now be found to be 112° – 30′. This operation is completed until we have gone over the ground from end to end.

Let it now be observed that the reading at B was 247° – 30′; this, deducted from 270°, leaves 22° – 30′ = to the angle CBL, of which CL is the sine, or departure, in the tables, and BL the cosine, or the latitude. The reading at C was 112° – 30′; deducting this from 180°, leaves 67° – 30′, of which LE is the sine, or departure, and LC the cosine, or latitude.

General Rule.—Where the reading is less than 90°, subtract the reading from 90°, which will leave the angle required; when the reading is more than 90°, and less than 180°, subtract the reading from 180°, which will give the angle required; when above 180°, and less than 270°, subtract the reading from 270°; and similarly, where the reading is above 270°, and less than 360°, deduct the reading from 360°: in each case the remainder will give the angle required.

In the practice of traverse surveying we always *make* the reading 5′, 10′, or 15′, &c., according to convenience, by moving the poles, or making our marks on walls, &c., a little to the right or left; this will be found a great practical advantage, inasmuch as it does away with all fractions of minutes, and increases the clearness of reading, a matter of the greatest importance in traverse surveying, for the special purposes we are now considering.

It is to be observed that in the usual practice of traverse surveying, we measure the sides and angles round any polygonal figure, regular or irregular, and that in doing so we go as far north as we do south, and as far east as we do west, and that consequently the 'southings' are equal to the 'northings,' and that 'eastings' are equal to the 'westings.'

Now the 'Differences of Latitudes,' or the northings and southings of any line, are the distances that the ends of lines measured round any polygon are north or south of the other ends.

The 'eastings' or 'westings,' or departures of any lines, are the perpendicular distances from one end of the lines to a meridian, or line passing south and north through the other end, the 'meridians' being parallel lines supposed to pass through every station on a survey. In any polygon, regular or irregular, the sum of all the *interior* angles is equal to twice as many right-angles as the figure has sides, less four right-angles.

As observed above, and as may be seen by referring to the figure at

p. xiv., whether we consider the regular octagon or the circle, in going round the polygon, we go as far north as south, and as far east as west; therefore, when we reduce the 'northings' and 'southings' of all the lines from the tables of Difference of Latitude, and similarly when we reduce the eastings and westings of all the lines from the Tables of Departures, we at once have proof of the accuracy of the work, since the northings will be equal to the southings, and the eastings equal to the westings, if the chaining has been correctly done.

In the same manner, we shall have proof of the angles having been correctly measured, because all the *interior* angles will be equal to twice as many right-angles as the polygon has sides, less four right-angles, or 180°, if the theodolite has been correctly used. There will, however, generally be some two or three minutes difference, even with the most careful work, unless some particular plan be adopted, such as that which has been mentioned above, of *making* the readings 5′, 10′, or 15′, &c., by making our marks accordingly. In the description of work to which we have been more particularly referring to, a difference of two or three minutes might be of considerable importance; at least for a *working* survey amongst buildings we should object to it, and the more so that it may be avoided; but in country surveying, or where looking such *minute* accuracy would be loss of time, it is usual to divide the difference or error over the work.

In the example we have given of traverse surveying at p. xxi., it might be very inconvenient to have to go round; but the work may be proved by going over the work a second time, but *backwards*, so that we shall still have our northings equal to southings, and our eastings equal to westings.

It is very possible that to many this going over the lines a second time may appear fastidious, but in fact it consumes but very little time, from the work having been already all set out; and, in the next place, it removes all doubts from the mind of the surveyor, as well as from that of the chief for whom he may be working. Where, on the contrary, the work has not been *proved*, the surveyor will feel perhaps for months afterwards uncertainty about his plans; and if any hitch occurs in the setting out of the works, he will be sure to feel no small amount of uneasiness, and attribute the difficulty to some possible error in his work.

As to the degree of accuracy which we have considered necessary in town lands surveys for the purpose here contemplated, we will only point out that the mistake of a foot may be of far greater importance than a foot error in a cutting or embankment on an ordinary section, for in this last case it would only involve some difference as to a greater or less quantity of earthwork; but serious as such a blunder would be, it would be trifling compared to the setting out works so that any portion of them might fall a foot within instead of outside of a building. The engineer who has had to set out works through ground thickly covered with buildings, knows all the importance of a correct plan for such purposes.

In the theodolite we are now referring to, it will be observed that there is a lower telescope, which is so set that its axis perfectly coincides with that of the upper telescope, when at zero; there is also a diagonal eye-piece, so made that when screwed into the telescope, it admits of its being pointed *directly vertical*, and of observations being made in such direction with as much facility as if the glass were pointed horizontally; this is a considerable advantage, as it allows of underground-works being connected in the most direct manner with the surface. Further, by the special construction of this instrument, when any particular point has been found on the surface, there are means of setting out from such point any angle taken underground, without making any alteration on the vernier plate: that is to say, that leaving all screws fast clamped, the instrument may be brought from underground works to any fixed point on the surface, and any particular angle set out or checked, one or both sides of which shall exactly coincide with fixed underground lines. The vernier zero being made to coincide exactly with zero on the limb, and the instrument turned round until the needle points to its own zero, both telescopes will be in the same vertical plane; any angle being now taken may be transferred to the surface, and the large size of the compass will show the slightest deviation that may have taken place.

In ranging curves, the addition of the second telescope is important, inasmuch as it enables the observer to be always satisfied that the zero of the instrument, during the course of any number of observations, has not deviated from the direction of the tangent. Any want of check on such deviation is often a source of error in setting out long curves, and is often caused by the observer moving about the instrument without sufficient care, or by his attempting thoughtlessly to move the vernier plate without having first released its clamping-screw. Such errors are often carried to the end of the curve, where they become greatly increased; they are frequently then *rectified* (!) by what is termed *easing* the curve, which simply means that at one end a curve is often of a radius 5 or 10 chains shorter than it should be.

PLOTTING TOWN SURVEYS BY TRAVERSE TABLES.

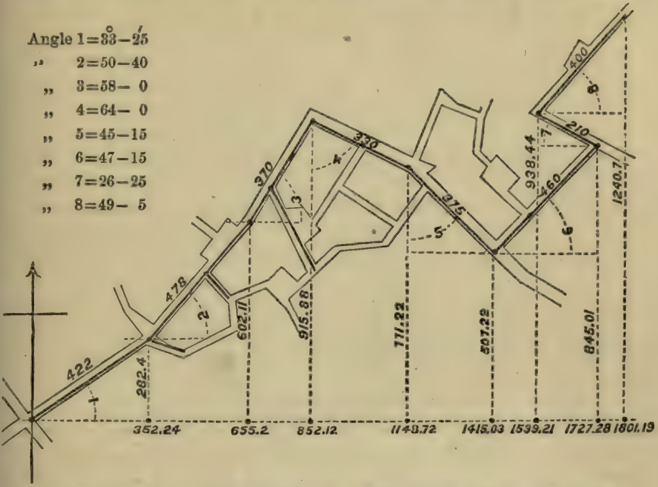
Since the introduction of railway and other great engineering works into the very centres of large towns—as, for instance, of the railways now constructed or about to be constructed in the parts of London covered with valuable property—the accuracy of working surveys has become of the very highest importance. Not only is it by these plans that it is determined whether buildings and parts of buildings lie on the line of works, but often there are no other means of setting out these works than by the working plans.

Not only important and expensive working drawings are got out according to the plans, and often become of no value if these are wrong, but the works themselves are frequently set out from the plans only, and immense difficulties must be the consequence if they are incorrect. Some considerable length of curve, or straight line, may be laid down on a plan drawn to a very large scale, and properties are often purchased in portions only, and not consecutively, and the works are of necessity set out from the plans and commenced; and if they have not been correctly surveyed, and also correctly plotted, very serious consequences may result: not only may we find that we interfere with buildings we did not contemplate touching, but the relative position of the centre lines may be wrong; and where masses of buildings intervene between works commenced in two different places, it is often very difficult to check satisfactorily the operations of setting out by work done on the ground. In short, the work is altogether different from ranging curves and straight lines through fields, or even villages and small country towns.

The writer believes that, generally, it is the system of *plotting* the survey which is at fault. If the ground is well traversed with a good theodolite, and the lines carefully chained, this part of the work can scarcely be otherwise than satisfactory; but the means adopted usually for laying down upon paper long lines (often from 15 to 30 inches and more) exactly at the angles, the writer considers unsatisfactory. The instrument used for laying off angles is the protractor, perfect it is admitted within certain limits, and the same may be said of the large parallels employed in the next operation of plotting a traverse survey in the usual manner. For ordinary purposes nothing can be better; but an extensive survey, plotted to a large scale (and 20 feet to the inch is not too large for the purpose we have now in view), requires altogether a different method in order to attain the accuracy necessary for important works.

By means of the Traverse Tables, a good survey may be plotted in the same manner and with the same amount of accuracy as a section, as the accompanying diagram will explain.

From the Traversing Notes, the Angles 1, 2, 3, &c., on the accompanying diagram, are obtained, the lengths A B, B C, C D, &c. being most carefully chained. To illustrate the method of plotting, it will be sufficient to give one example, as the work otherwise would be merely a repetition of what has been said under the head of 'Levelling with the Theodolite,' pp. vii.–viii. Angle 1 is 33° 25′, and the measured length up the side of the street is 422 feet; at page 91 (Table II.) we



have 'Departures' corresponding to 'Difference of Levels,' and for 33° 25′ we have for

feet. feet.
400 = 220·29
20 = 11·014
2 = 1·1014
422 = 232·4054

—and for 'Latitudes,' corresponding to 'Horizontal Distances for Difference of Levels,' we have for

feet. feet.
400 = 333·88
20 = 16·694
2 = 1·669
422 = 352·243

Both these results are shown plotted on the diagram for Angle 1, and similarly for the other angles.

When the first portion of the survey, as from 1 to 8, has been completed, the smaller areas may be enclosed and *plotted in the same manner*. It will be seen that by these means, the most minute accuracy is ensured for the whole as well as for the details of the survey. When the work has proceeded thus far, the centre line of the works should be laid down, and the details of the 'blocks' should then be filled into the width required.

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Note to Binder—pp. 1 *to* 4 *are cancelled.*

EXPLANATION OF TABLES.

TABLE I.

The first columns of Table I. have been prepared to show at a glance, on either plans or cross sections, the rise and fall due to the angles of declivity of side-lying ground. As regards earthworks, the importance of this can hardly be over-estimated when we are laying down a line either for a railway, road, or canal, because it affords a ready means of ascertaining depths of cuttings and embankments, and of making suitable alterations in the direction of the centre line of works. Generally, the information which we are desirous of obtaining on this point, is the difference of the levels right and left of a line at a distance of perhaps two or three hundred feet; this is given at a glance by the tabular numbers, when the angles of acclivity or declivity have been taken;—thus column 2 gives the rise or fall per cent horizontal, all in yards, feet, or metres, for every five minutes of every angle of inclination, which an explorer may at once write down in his note-book without any calculation whatever, and the surveyor may make the same observations in his field-book right or left of any of his chain lines, whilst making his survey. If these lines are laid down on the plot plan, the differences of levels are easily plotted at the same time, with all sufficient accuracy for the purpose in hand. In a hilly country, particularly, these notes on a plan afford the readiest means of avoiding as much as possible heavy cuttings and embankments.

With the exception of the theodolite, which, however, is much too cumbrous to be always carried about for taking angles of inclination, the writer is not acquainted with any practically useful inclinometer, except that which he has used for many years past.* This consists of a semicircular protractor, with a pendulum pointing to zero when the instrument is held horizontal; it is numbered from zero to ninety degrees both ways, so that when used in taking an angle of elevation or depression, the pendulum at once reads off the observed angle, and with much greater steadiness and accuracy than might at the first glance be expected; if the pendulum be sufficiently weighted, say, with about two ounces.

With a six-inch semicircular protractor, with the vernier loaded, no difficulty will be found in reading off to three or four minutes, and for the short distances and the purposes for which the inclinometer could be used, this is abundantly accurate; the instrument is furnished with plain sights, the axis of which is, of course, made by the manufacturer, parallel with the diameter of the instrument. Fig. 1 is a sketch of the instrument. It reads to twenty-two degrees, and as the line of sight AB is parallel to the ground line CD, twenty-two degrees is the angle of inclination, and the table supplies the amount of rise for every hundred *horizontal*. The writer trusts that he may be excused for mentioning for the information of the young engineering surveyor, that one-half of the cardboard protractors sold by our instrument makers may readily be fixed in a plain glazed flat case, and that with a pendulum attached it will make a very useful instrument for such purposes. The great advantage of such an instrument is the readiness and rapidity with which it supplies, with the assistance of the tables, the rise and fall for ordinary cross sections.

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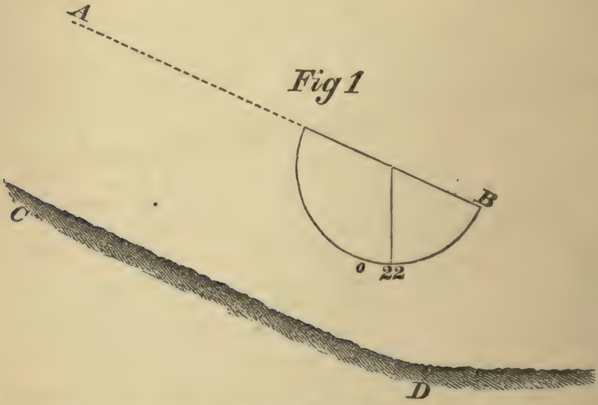
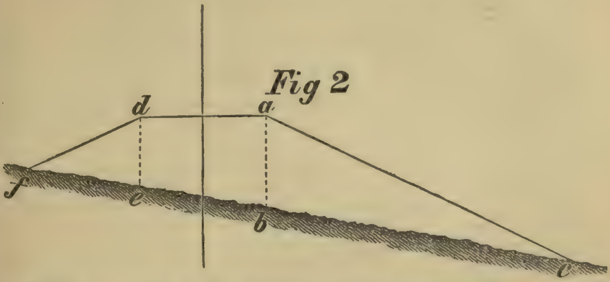
* The writer, however, wishes to guard himself against any imputation of claiming either discovery or invention in so simple a matter, and is only desirous of making more generally known a really useful inclinometer for ordinary purposes.

Fig 1



The second portion of Table I. gives a series of coefficients for setting out slopes where the cross section is in steeply side-lying ground, of which the angle of inclination has been taken; the writer considers that where the ground rises or falls rapidly, this furnishes a better mode of setting out the slopes of earth-work than the ordinary method by differences of level.

Let fig. 2 represent an embankment, 2 to 1 slopes, of 20·2 in depth on side-lying ground, of which the angle of inclination has been measured. Column 4 of Table I. gives the rise or fall per unit. Take this tabular number opposite to the angle of inclination, *multiply* it by 20·2, and the product *added* to 20·2 will give the depth due to *a b*, and *a b* multiplied by the *major* coefficient, for slopes 2 to 1, gives the distance *b c*. On the other side the first tabular number multiplied by 20·2 is *deducted* instead of added, to get the depth *d e*, which, multiplied by the *minor* coefficient for slopes 2 to 1, will give the distance *f e*: observe, that in both cases



the lengths *b c*, and *f e*, are measured along the *sloping* surface and not horizontally, which ensures a much more accurate setting off where the earthworks are heavy, and the natural surface of the ground considerably inclined.

TABLE II.

Table II. is a traverse table for every five minutes of the quadrant which will be found a sufficiently close approximation for all surveying purposes, as we can always manage to lay out our work to five minutes and generally even to ten minutes. It is constructed so that the *Latitudes* and *Departures* are given in one page for lengths from 10 to 90, and of course by the mere removal of the decimal point one figure to the left, from 1 to 9, and similarly by the removal one point to the right from 100 to 900, and so on.

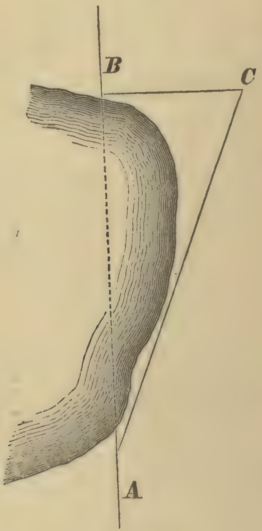
Independently of its use for regular traverse surveying it will often be found useful in the field in getting round obstacles, as for instance, in fig. 3, where a large sheet of water comes across the base line AB. From A set out any convenient angle BAC, equal to, say 22 degrees, and measure along AC, until the obstacle is so cleared on the other side that from a point C we may set out an angle ACB of 68 degrees, (22 + 68 being equal to 90). Let AC measure 1250 feet; required the length of AB. By table of latitudes we shall have for 22 degrees,

927·18	1000
185·44	200
46·36	50
1158·98	1250

or 1158·98 feet for the length of AB, and if the angles have been properly set out, CB will measure 468·26, for, by the table of departures we shall have for 22 degrees,

374·61—1000
74·92— 200
18·73— 50
468·26—1250

Table II. has been so arranged, that the horizontal distances and differences of levels due to inclination are very readily obtained in the same manner, when the angle of elevation or depression has been taken, and *length along the sloping ground carefully measured.* In the last example, for instance, if the angle of 22 degrees were an angle of elevation, and the distance 1250 feet, the length measured *along the sloping ground*, then we should have 1158·98 for the horizontal distance, and 468·26 feet for the difference of level.



It will be needless to observe here, that in a case of taking levels by inclination, we should not recommend such a distance to be taken at one sight, and we have only done so here in order to show how the use of this table is applicable in both cases, with regard to surveying and levelling, and in mountainous countries, when a good theodolite is carefully used, a great amount of country is levelled over very rapidly, and as regards cross sections the inclinometer mentioned above does all that is required very easily with these tables, as all calculations are avoided.

TABLE III.

Table III. has been prepared with a view of avoiding in the field all the computations of tangential angles in setting out circular curves. These calculations are simple enough, and yet troublesome in order to ensure accuracy, for one error may involve the loss of many hours' field work; besides, however rapidly they may be made, the time given to them will always be more advantageously devoted on the theodolite, and seeing that the chainmen do their work accurately, for unless the curve be well chained, there can be no hope of closing the curve satisfactorily. It will be needless to observe that the table is based upon the formula,

$$\frac{1718{\cdot}9}{\text{Radius}} = \text{Tangential angle for one chord.}$$

It will also be almost as supererogatory to observe that, generally speaking, in setting out curves, the first stump is upon a fraction of a chain. To make use of these tables with all desirable rapidity, it is only necessary to set out at first with the fraction of the tangential angle due to the fraction of chain; when this has been carefully done, the instrument may at once be removed, and a considerable length set out from such station.

For sharp curves it will be observed that the tangential angles have been given by half instead of whole chains, which will be found to give more satisfactory results for curves of short radius.

TABLE IV.

Table IV. is a table for railway crossings, which is too explicit to need any further information on the subject.

TABLE I.

Angles of Elevation and Depression	Reduction for Chainage	Rise or Fall per Hundred Horizontal	Ratio of Inclination	Rise or Fall per Unit Horizontal	SETTING OUT HALF-WIDTHS									Angles of Elevation and Depression
					Coefficient for Formation	2 to 1		1½ to 1		1¼ to 1		1 to 1		
						Major Coefficient	Minor Coefficient	Major Coefficient	Minor Coefficient	Major Coefficient	Minor Coefficient	Major Coefficient	Minor Coefficient	
1°—0′	0·02	1·74	57·3	0·0174	1·0001	2·074	1·934	1·541	1·462	1·278	1·223	1·018	0·983	1°—0′
5	02	1·89	52·9	0·0189	1·0002	2·081	1·928	1·544	1·459	1·280	1·220	1·019	0·982	5
10	02	2·04	49·1	0·0204	1·0002	2·087	1·923	1·548	1·456	1·283	1·218	1·021	0·981	10
15	02	2·18	45·8	0·0218	1·0002	2·094	1·917	1·552	1·453	1·285	1·216	1·022	0·979	15
20	03	2·34	42·9	0·0234	1·0003	2·100	1·912	1·555	1·450	1·287	1·214	1·024	0·978	20
25	03	2·47	40·4	0·0247	1·0003	2·107	1·907	1·558	1·447	1·289	1·212	1·025	0·976	25
30	0·03	2·63	38·2	0·0263	1·0003	2·113	1·902	1·562	1·444	1·292	1·210	1·027	0·975	30
35	04	2·76	36·2	0·0276	1·0004	2·120	1·897	1·566	1·441	1·294	1·208	1·028	0·974	35
40	04	2·91	34·4	0·0291	1·0004	2·126	1·892	1·569	1·438	1·297	1·206	1·030	0·972	40
45	05	3·05	32·7	0·0305	1·0005	2·133	1·887	1·573	1·435	1·299	1·204	1·031	0·971	45
50	05	3·20	31·2	0·0320	1·0005	2·140	1·882	1·577	1·432	1·302	1·202	1·033	0·970	50
55	06	3·35	29·9	0·0335	1·0006	2·146	1·877	1·581	1·429	1·305	1·200	1·034	0·968	55
2—0	0·06	3·49	28·6	0·0349	1·0006	2·153	1·872	1·584	1·426	1·307	1·198	1·036	0·967	2—0
5	07	3·65	27·5	0·0365	1·0007	2·160	1·867	1·588	1·423	1·310	1·196	1·038	0·966	5
10	07	3·82	26·4	0·0382	1·0007	2·167	1·862	1·592	1·421	1·312	1·194	1·039	0·964	10
15	08	3·99	25·4	0·0399	1·0008	2·174	1·857	1·596	1·418	1·315	1·192	1·041	0·963	15
20	08	4·15	24·5	0·0415	1·0008	2·181	1·852	1·600	1·415	1·318	1·190	1·043	0·962	20
25	0·09	4·32	23·7	0·0432	1·0009	2·188	1·847	1·604	1·412	1·320	1·188	1·045	0·960	25
30	09	4·49	22·9	0·0449	1·0010	2·195	1·842	1·607	1·409	1·323	1·186	1·046	0·959	30
35	10	4·61	22·2	0·0461	1·0010	2·202	1·838	1·611	1·407	1·326	1·184	1·048	0·957	35
40	11	4·73	21·5	0·0473	1·0011	2·209	1·834	1·615	1·404	1·328	1·182	1·050	0·956	40
45	11	4·85	20·8	0·0485	1·0012	2·218	1·829	1·619	1·401	1·331	1·180	1·052	0·955	45
50	12	4·97	20·2	0·0497	1·0012	2·225	1·824	1·623	1·398	1·334	1·178	1·053	0·954	50
55	13	5·09	19·6	0·0509	1·0013	2·233	1·819	1·627	1·395	1·336	1·176	1·055	0·952	55
3—0	0·14	5·24	19·1	0·0524	1·0014	2·239	1·814	1·631	1·393	1·339	1·174	1·057	0·951	3—0
5	14	5·39	18·6	0·0539	1·0014	2·247	1·809	1·635	1·390	1·342	1·172	1·059	0·950	5
10	15	5·53	18·1	0·0553	1·0015	2·254	1·804	1·639	1·387	1·345	1·170	1·060	0·948	10

15	16	5·68	17·6	0·0568	1·0016	2·262	1·800	1·643	1·385	1·347	1·168	1·062	0·947	15
20	17	5·82	17·2	0·0582	1·0017	2·269	1·795	1·647	1·382	1·350	1·166	1·064	0·946	20
25	18	5·97	16·7	0·0597	1·0018	2·277	1·791	1·651	1·380	1·353	1·165	1·065	0·945	25
30	0·19	6·12	16·3	0·0612	1·0019	2·285	1·786	1·655	1·377	1·356	1·163	1·067	0·944	30
35	20	6·26	16·0	0·0626	1·0020	2·292	1·781	1·659	1·374	1·359	1·161	1·069	0·942	35
40	20	6·41	15·6	0·0641	1·0021	2·298	1·777	1·663	1·372	1·361	1·159	1·070	0·941	40
45	21	6·55	15·3	0·0655	1·0021	2·305	1·773	1·667	1·369	1·364	1·157	1·072	0·940	45
50	22	6·70	14·9	0·0670	1·0022	2·311	1·768	1·671	1·366	1·367	1·155	1·074	0·938	50
55	23	6·85	14·6	0·0685	1·0023	2·318	1·764	1·675	1·364	1·370	1·154	1·075	0·937	55
4—0	0·24	6·99	14·3	0·0699	1·0024	2·325	1·760	1·680	1·361	1·373	1·152	1·077	0·936	4—0
5	25	7·14	14·0	0·0714	1·0025	2·334	1·755	1·684	1·358	1·376	1·150	1·079	0·934	5
10	26	7·28	13·7	0·0708	1·0026	2·344	1·751	1·688	1·356	1·378	1·148	1·081	0·933	10
15	27	7·43	13·5	0·0743	1·0028	2·354	1·747	1·692	1·353	1·381	1·146	1·083	0·932	15
20	29	7·58	13·2	0·0758	1·0029	2·364	1·742	1·696	1·351	1·384	1·144	1·085	0·931	20
25	30	7·72	12·9	0·0772	1·0030	2·373	1·738	1·699	1·348	1·387	1·143	1·086	0·930	25
30	0·31	7·87	12·7	0·0787	1·0031	2·383	1·734	1·702	1·346	1·390	1·141	1·088	0·929	30
35	32	8·02	12·5	0·0802	1·0032	2·392	1·730	1·707	1·343	1·393	1·139	1·090	0·928	35
40	33	8·16	12·3	0·0816	1·0033	2·400	1·726	1·712	1·341	1·396	1·138	1·092	0·927	40
45	34	8·31	12·0	0·0831	1·0034	2·409	1·722	1·717	1·338	1·400	1·136	1·094	0·926	45
50	36	8·45	11·8	0·0845	1·0036	2·418	1·718	1·722	1·336	1·402	1·134	1·096	0·925	50
55	37	8·60	11·6	0·0860	1·0037	2·427	1·714	1·728	1·333	1·405	1·133	1·098	0·924	55
5—0	0·38	8·75	11·4	0·0875	1·0038	2·436	1·710	1·734	1·331	1·408	1·131	1·100	0·923	5—0
5	39	8·89	11·2	0·0889	1·0039	2·445	1·706	1·739	1·329	1·411	1·129	1·102	0·922	5
10	41	9·04	11·1	0·0904	1·0041	2·455	1·702	1·744	1·327	1·414	1·127	1·104	0·921	10
15	42	9·19	10·9	0·0919	1·0042	2·464	1·698	1·749	1·325	1·418	1·125	1·106	0·920	15
20	43	9·33	10·7	0·0933	1·0043	2·473	1·694	1·754	1·323	1·421	1·124	1·108	0·919	20
25	45	9·48	10·5	0·0948	1·0045	2·482	1·690	1·759	1·321	1·424	1·122	1·109	0·918	25
30	0·46	9·63	10·4	0·0963	1·0046	2·491	1·686	1·762	1·319	1·427	1·120	1·111	0·917	30
35	47	9·77	10·2	0·0977	1·0048	2·501	1·683	1·767	1·317	1·430	1·119	1·113	0·916	35
40	49	9·92	10·1	0·0992	1·0049	2·510	1·679	1·772	1·315	1·434	1·117	1·115	0·915	40
45	50	10·07	9·93	0·1007	1·0051	2·520	1·675	1·777	1·313	1·437	1·115	1·117	0·914	45
50	52	10·21	9·79	0·1021	1·0052	2·530	1·671	1·782	1·311	1·440	1·113	1·119	0·913	50
55	53	10·36	9·66	0·1026	1·0054	2·539	1·667	1·787	1·309	1·444	1·112	1·121	0·911	55

TABLE I.

Angles of Elevation and Depression	Reduction for Chainage	Rise or Fall per Hundred Horizontal	Ratio of Inclination	Rise or Fall per Unit Horizontal	SETTING OUT HALF-WIDTHS									Angles of Elevation and Depression
					Coefficient for Formation	2 to 1		1½ to 1		1¼ to 1		1 to 1		
						Major Coefficient	Minor Coefficient	Major Coefficient	Minor Coefficient	Major Coefficient	Minor Coefficient	Major Coefficient	Minor Coefficient	
6° — 0′	0·55	10·51	9·52	0·1051	1·0055	2·549	1·663	1·791	1·307	1·447	1·110	1·123	0·910	6° — 0′
5	0·56	10·66	9·39	0·1066	1·0056	2·559	1·660	1·796	1·305	1·451	1·108	1·125	0·909	5
10	58	10·80	9·27	0·1080	1·0058	2·569	1·656	1·801	1·302	1·459	1·107	1·127	0·908	10
15	59	10·95	9·15	0·1095	1·0060	2·579	1·652	1·806	1·299	1·457	1·105	1·129	0·907	15
20	61	11·10	9·02	0·1110	1·0061	2·589	1·648	1·811	1·297	1·461	1·104	1·131	0·906	20
25	63	11·25	8·90	0·1125	1·0063	2·599	1·644	1·816	1·295	1·464	1·103	1·133	0·905	25
30	0·64	11·39	8·78	0·1139	1·0065	2·609	1·640	1·821	1·293	1·468	1·101	1·136	0·904	30
35	66	11·54	8·67	0·1154	1·0066	2·620	1·637	1·826	1·291	1·472	1·099	1·138	0·903	35
40	68	11·69	8·56	0·1169	1·0068	2·630	1·634	1·832	1·288	1·475	1·098	1·140	0·902	40
45	69	11·83	8·46	0·1183	1·0070	2·641	1·630	1·837	1·286	1·479	1·096	1·142	0·901	45
50	71	11·98	8·35	0·1198	1·0072	2·651	1·626	1·842	1·284	1·482	1·095	1·144	0·900	50
55	73	12·13	8·25	0·1213	1·0073	2·662	1·623	1·847	1·281	1·486	1·093	1·146	0·899	55
7 — 0	0·75	12·28	8·14	0·1228	1·0075	2·673	1·619	1·853	1·279	1·489	1·092	1·148	0·897	7 — 0
5	76	12·43	8·05	0·1243	1·0077	2·684	1·615	1·858	1·277	1·492	1·091	1·150	0·896	5
10	78	12·57	7·96	0·1257	1·0079	2·695	1·611	1·864	1·274	1·496	1·089	1·152	0·895	10
15	80	12·72	7·87	0·1272	1·0081	2·705	1·608	1·869	1·272	1·499	1·088	1·155	0·894	15
20	82	12·87	7·78	0·1287	1·0082	2·716	1·604	1·875	1·270	1·503	1·086	1·157	0·893	20
25	84	13·02	7·69	0·1302	1·0084	2·727	1·601	1·880	1·267	1·507	1·085	1·159	0·892	25
30	0·86	13·16	7·60	0·1316	1·0086	2·738	1·597	1·886	1·265	1·510	1·083	1·161	0·891	30
35	87	13·31	7·52	0·1331	1·0088	2·750	1·593	1·891	1·263	1·514	1·081	1·164	0·890	35
40	89	13·46	7·44	0·1346	1·0090	2·762	1·590	1·897	1·260	1·517	1·080	1·166	0·889	40
45	91	13·61	7·35	0·1361	1·0092	2·774	1·586	1·902	1·258	1·521	1·079	1·168	0·888	45
50	93	13·76	7·27	0·1376	1·0094	2·787	1·583	1·908	1·256	1·524	1·077	1·170	0·887	50
55	95	13·91	7·19	0·1391	1·0096	2·799	1·580	1·913	1·253	1·528	1·076	1·173	0·886	55
8 — 0	0·97	14·05	7·11	0·1405	1·0098	2·812	1·577	1·920	1·251	1·531	1·074	1·175	0·885	8 — 0
5	99	14·20	7·04	0·1420	1·0100	2·825	1·573	1·926	1·249	1·535	1·073	1·177	0·884	5
10	1·01	14·35	6·97	0·1435	1·0102	2·837	1·570	1·932	1·247	1·539	1·071	1·180	0·883	10

15	1·03	14·50	6·90	0·1450	1·0105	2·850	1·567	1·937	1·245	1·543	1·070	1·182	0·882	15
20	1·06	14·65	6·83	0·1465	1·0107	2·863	1·564	1·943	1·243	1·547	1·068	1·184	0·881	20
25	1·07	14·80	6·76	0·1480	1·0109	2·875	1·561	1·949	1·241	1·551	1·066	1·187	0·880	25
30	1·10	14·94	6·69	0·1494	1·0111	2·888	1·558	1·955	1·239	1·555	1·065	1·189	0·879	30
35	1·12	15·09	6·63	0·1509	1·0113	2·901	1·554	1·961	1·237	1·558	1·064	1·191	0·878	35
40	1·14	15·24	6·57	0·1524	1·0116	2·914	1·551	1·967	1·235	1·561	1·062	1·194	0·877	40
45	1·16	15·39	6·50	0·1539	1·0118	2·927	1·548	1·973	1·233	1·565	1·061	1·196	0·876	45
50	1·19	15·54	6·44	0·1554	1·0120	2·940	1·545	1·979	1·231	1·569	1·059	1·198	0·875	50
55	1·21	15·69	6·38	0·1569	1·0122	2·953	1·542	1·985	1·229	1·573	1·057	1·201	0·875	55
9—0	1·23	15·84	6·31	0·1584	1·0125	2·967	1·539	1·992	1·227	1·577	1·056	1·203	0·874	9—0
5	1·25	15·99	6·26	0·1599	1·0127	2·981	1·535	1·998	1·225	1·581	1·055	1·205	0·873	5
10	1·28	16·13	6·20	0·1613	1·0129	2·995	1·532	2·005	1·223	1·585	1·053	1·208	0·872	10
15	1·30	16·28	6·15	0·1628	1·0132	3·009	1·529	2·012	1·221	1·589	1·052	1·210	0·871	15
20	1·32	16·43	6·09	0·1643	1·0134	3·023	1·526	2·018	1·219	1·593	1·050	1·213	0·870	20
25	1·35	16·58	6·03	0·1658	1·0136	3·038	1·523	2·025	1·218	1·597	1·049	1·215	0·869	25
30	1·37	16·73	5·98	0·1673	1·0140	3·052	1·520	2·031	1·216	1·602	1·047	1·218	0·869	30
35	1·40	16·88	5·93	0·1688	1·0142	3·067	1·517	2·038	1·214	1·606	1·046	1·220	0·868	35
40	1·42	17·03	5·87	0·1703	1·0144	3·081	1·514	2·044	1·212	1·610	1·044	1·223	0·867	40
45	1·44	17·18	5·82	0·1718	1·0147	3·096	1·511	2·051	1·210	1·614	1·043	1·225	0·866	45
50	1·47	17·33	5·77	0·1733	1·0149	3·111	1·508	2·057	1·208	1·618	1·041	1·228	0·865	50
55	1·49	17·48	5·72	0·1748	1·0152	3·126	1·505	2·064	1·207	1·622	1·040	1·230	0·864	55
10—0	1·52	17·63	5·67	0·1763	1·0154	3·141	1·502	2·071	1·205	1·627	1·039	1·233	0·863	10—0
5	1·54	17·78	5·63	0·1778	1·0157	3·157	1·500	2·078	1·203	1·632	1·038	1·236	0·862	5
10	1·57	17·93	5·58	0·1793	1·0160	3·173	1·497	2·086	1·202	1·636	1·037	1·238	0·861	10
15	1·60	18·08	5·53	0·1808	1·0162	3·189	1·494	2·093	1·201	1·641	1·035	1·241	0·861	15
20	1·62	18·23	5·49	0·1823	1·0164	3·205	1·491	2·100	1·199	1·645	1·034	1·244	0·860	20
25	1·65	18·38	5·44	0·1838	1·0168	3·221	1·488	2·108	1·198	1·650	1·032	1·247	0·859	25
30	1·67	18·53	5·40	0·1853	1·0170	3·236	1·485	2·115	1·196	1·654	1·031	1·249	0·858	30
35	1·70	18·68	5·35	0·1868	1·0173	3·253	1·483	2·122	1·194	1·659	1·030	1·252	0·857	35
40	1·73	18·83	5·31	0·1883	1·0176	3·270	1·480	2·129	1·192	1·663	1·029	1·255	0·856	40
45	1·75	18·98	5·27	0·1898	1·0179	3·287	1·477	2·136	1·190	1·668	1·028	1·257	0·855	45
50	1·78	19·14	5·23	0·1914	1·0181	3·303	1·474	2·143	1·188	1·672	1·027	1·260	0·855	50
55	1·81	19·29	5·19	0·1929	1·0184	3·320	1·471	2·150	1·186	1·677	1·025	1·263	0·854	55

TABLE I.

Angles of Elevation and Depression	Reduction for Chainage	Rise or Fall per Hundred Horizontal	Ratio of Inclination	Rise or Fall per Unit Horizontal	SETTING OUT HALF-WIDTHS									Angles of Elevation and Depression
					Coefficient for Formation	2 to 1		1½ to 1		1¼ to 1		1 to 1		
						Major Coefficient	Minor Coefficient	Major Coefficient	Minor Coefficient	Major Coefficient	Minor Coefficient	Major Coefficient	Minor Coefficient	
11°–0′	1·84	19.44	5·14	0·1944	1·0187	3·335	1·468	2·158	1·183	1·681	1·024	1·265	0·853	11°–0′
5	1·86	19·59	5·11	0·1959	1·0190	3·353	1·466	2·166	1·181	1·686	1·023	1·268	0·852	5
10	1·89	19·74	5·07	0·1974	1·0193	3·371	1·463	2·173	1·179	1·691	1·021	1·270	0·851	10
15	1·92	19·89	5·03	0·1989	1·0196	3·389	1·460	2 181	1·178	1·695	1·020	1·273	0·850	15
20	1·95	20·04	4·99	0·2004	1·0199	3·407	1·457	2·189	1·176	1·700	1·019	1·276	0·850	20
25	1·98	20·19	4·95	0·2019	1·0202	3·425	1·454	2·196	1·174	1·705	1·018	1·279	0·849	25
30	2·01	20·35	4·91	0·2035	1·0205	3·444	1·451	2·204	1·173	1·710	1·017	1·281	0·848	30
35	2·04	20·50	4·88	0·2050	1·0208	3·463	1·449	2·212	1·171	1·715	1·015	1·284	0·847	35
40	2·07	20·65	4·84	0·2065	1·0211	3·482	1·446	2·220	1·170	1·719	1·014	1·287	0·846	40
45	2·10	20·80	4·81	0·2080	1·0214	3·501	1·444	2·228	1·168	1·724	1·013	1·290	0·846	45
50	2·13	20·95	4·77	0·2095	1·0217	3·520	1·441	2·236	1·166	1·729	1·011	1·292	0·845	50
55	2·15	21·10	4·74	0·2110	1·0220	3·540	1·439	2·244	1·164	1·734	1·010	1·295	0·844	55
12–0	2·19	21·26	4·70	0·2126	1·0223	3·560	1·436	2·252	1·163	1·739	1·009	1·298	0·843	12–0
5	2·22	21·41	4·67	0·2141	1·0227	3·580	1·434	2·261	1·161	1·744	1·008	1·301	0·842	5
10	2·25	21·56	4·64	0·2156	1·0230	3·601	1·431	2·269	1·160	1·750	1·007	1·304	0·842	10
15	2·28	21·71	4 61	0·2171	1·0233	3·621	1·428	2·278	1·158	1·755	1·005	1·307	0·841	15
20	2·31	21·86	4·57	0·2186	1·0236	3·642	1·425	2·286	1·156	1·760	1·004	1·310	0·840	20
25	2·34	22·01	4·54	0·2201	1·0240	3·662	1·422	2·295	1·155	1·766	1·003	1·313	0·839	25
30	2·37	22·17	4·51	0·2217	1·0243	3·683	1·419	2·303	1·153	1·771	1·002	1·316	0·838	30
35	2·40	22·32	4·48	0·2232	1·0246	3·705	1·416	2·312	1·152	1·776	1·001	1·319	0·838	35
40	2·43	22·47	4·45	0·2247	1·0249	3·727	1·414	2·321	1·150	1·782	1·000	1·322	0·837	40
45	2·47	22·62	4·42	0·2262	1·0252	3·749	1·411	2·329	1·149	1·787	0·998	1·325	0·836	45
50	2·50	22·77	4·39	0·2277	1·0256	3 771	1·409	2·338	1·147	1·792	0·997	1·328	0·835	50
55	2·53	22·92	4·36	0·2292	1·0260	3·793	1·407	2·347	1·145	1·798	0·996	1·331	0·835	55
13–0	2·56	23·08	4·33	0·2308	1·0263	3·816	1·405	2·356	1·144	1·803	0·995	1·334	0·834	13–0
5	2·60	23·23	4·30	0·2323	1·0266	3·840	1·403	2·365	1·142	1·809	0·993	1·337	0·833	5
10	2·63	23·39	4·28	0·2339	1·0270	3·864	1·400	2·375	1·141	1·814	0·992	1·340	0·832	10

15	2·66	23·54	4·25	0·2354	1·0273	3·888	1·398	2·384	1·139	1·820	0·991	1·344	0·832	15
20	2·70	23·70	4·22	0·2370	1·0277	3·912	1·395	2·393	1·138	1·825	0·990	1·347	0·831	20
25	2·73	23·85	4·20	0·2385	1·0280	3·936	1·393	2·403	1·136	1·831	0·989	1·350	0·830	25
30	2·76	24·01	4·17	0·2401	1·0284	3·960	1·390	2·412	1·134	1·837	0·988	1·353	0·829	30
35	2·80	24·16	4·14	0·2416	1·0288	3·985	1·387	2·422	1·133	1·842	0·987	1·357	0·829	35
40	2·83	24·31	4·12	0·2431	1·0291	4·010	1·385	2·431	1·131	1·848	0·986	1·360	0·827	40
45	2·87	24·47	4·09	0·2447	1·0295	4·036	1·382	2·441	1·130	1·854	0·985	1·363	0·827	45
50	2·90	24·62	4·06	0·2462	1·0299	4·063	1·380	2·450	1·128	1·860	0·984	1·366	0·826	50
55	2·93	24·78	4·04	0·2478	1·0302	4·089	1·378	2·460	1·126	1·865	0·983	1·370	0·826	55
14—0	2·97	24·93	4·01	0·2493	1·0306	4·115	1·376	2·470	1·125	1·871	0·982	1·373	0·825	14—0
5	3·00	25·09	3·99	0·2509	1·0309	4·143	1·374	2·480	1·123	1·877	0·981	1·376	0·824	5
10	3·04	25·24	3·96	0·2524	1·0314	4·171	1·372	2·490	1·122	1·883	0·979	1·380	0·823	10
15	3·08	25·40	3·94	0·2540	1·0317	4·199	1·370	2·500	1·120	1·889	0·978	1·383	0·823	15
20	3·11	25·55	3·92	0·2555	1·0321	4·227	1·367	2·510	1·119	1·895	0·977	1·387	0·822	20
25	3·15	25·71	3·89	0·2571	1·0325	4·255	1·364	2·521	1·118	1·902	0·976	1·390	0·821	25
30	3·19	25·86	3·87	0·2586	1·0329	4·284	1·362	2·532	1·116	1·908	0·975	1·393	0·821	30
35	3·22	26·02	3·85	0·2602	1·0333	4·314	1·359	2·543	1·115	1·914	0·974	1·397	0·820	35
40	3·26	26·17	3·82	0·2617	1·0337	4·344	1·357	2·554	1·114	1·920	0·973	1·400	0·819	40
45	3·30	26·33	3·80	0·2633	1·0341	4·374	1·355	2·565	1·112	1·927	0·972	1·404	0·819	45
50	3·33	26·48	3·78	0·2648	1·0345	4·405	1·353	2·576	1·111	1·933	0·971	1·407	0·818	50
55	3·37	26·64	3·75	0·2664	1·0349	4·436	1·351	2·587	1·109	1·939	0·970	1·410	0·817	55
15—0	3·41	26·79	3·73	0·2679	1·0353	4·466	1·349	2·597	1·108	1·945	0·969	1·414	0·817	15—0
5	3·45	26·95	3·71	0·2695	1·0357	4·499	1·346	2·609	1·106	1·952	0·968	1·418	0·816	5
10	3·48	27·11	3·69	0·2711	1·0361	4·532	1·344	2·620	1·105	1·958	0·967	1·421	0·815	10
15	3·52	27·26	3·67	0·2726	1·0365	4·565	1·342	2·632	1·104	1·965	0·966	1·425	0·814	15
20	3·56	27·42	3·65	0·2742	1·0369	4·598	1·340	2·643	1·102	1·972	0·965	1·429	0·814	20
25	3·60	27·57	3·63	0·2757	1·0373	4·631	1·338	2·655	1·101	1·978	0·964	1·433	0·813	25
30	3·64	27·73	3·61	0·2773	1·0377	4·666	1·336	2·666	1·100	1·985	0·963	1·436	0·812	30
35	3·68	27·89	3·59	0·2789	1·0381	4·702	1·333	2·678	1·098	1·992	0·962	1·440	0·812	35
40	3·72	28·04	3·57	0·2804	1·0386	4·738	1·331	2·690	1·097	1·999	0·961	1·444	0·811	40
45	3·75	28·20	3·55	0·2820	1·0390	4·774	1·329	2·702	1·096	2·005	0·960	1.448	0·810	45
50	3·79	28·36	3·53	0·2836	1·0394	4·811	1·327	2·714	1·094	2·012	0·959	1·451	0·810	50
55	3·83	28·51	3·51	0·2851	1·0398	4·848	1·325	2·726	1·093	2·019	0·958	1·455	0·809	55

TABLE I.

Angles of Elevation and Depression	Reduction for Chainage	Rise or Fall per Hundred Horizontal	Ratio of Inclination	Rise or Fall per Unit Horizontal	SETTING OUT HALF-WIDTHS									Angles of Elevation and Depression.
					Coefficient for Formation	2 to 1		1½ to 1		1¼ to 1		1 to 1		
						Major Coefficient	Minor Coefficient	Major Coefficient	Minor Coefficient	Major Coefficient	Minor Coefficient	Major Coefficient	Minor Coefficient	
16°—0′	3·87	28·67	3·49	0·2867	1·0403	4·885	1·323	2·739	1·092	2·026	0·957	1·459	0·809	16°—0′
5	3·91	28·83	3·47	0·2883	1·0407	4·925	1·320	2·752	1·090	2·033	0·956	1·463	0·808	5
10	3·95	28·99	3·45	0·2889	1·0412	4·965	1·318	2·765	1·089	2·040	0·955	1·467	0·807	10
15	4·00	29·15	3·43	0·2915	1·0416	5·005	1·316	2·778	1·088	2·047	0·954	1·471	0·807	15
20	4·04	29·31	3·41	0·2931	1·0421	5·045	1·314	2·791	1·086	2·055	0·953	1·475	0·806	20
25	4·08	29·46	3·40	0·2946	1·0425	5·085	1·312	2·804	1·085	2·062	0·952	1·478	0·805	25
30	4·12	29·62	3·38	0·2962	1·0429	5·125	1·310	2·817	1·084	2·069	0·951	1·482	0·805	30
35	4·16	29·78	3·36	0·2978	1·0434	5·170	1·308	2·830	1·082	2·077	0·950	1·486	0·804	35
40	4·20	29·94	3·34	0·2994	1·0439	5·214	1·305	2·843	1·081	2·084	0·949	1·490	0·803	40
45	4·24	30·09	3·32	0·3009	1·0443	5·258	1·303	2·856	1·080	2·092	0·948	1·494	0·803	45
50	4·28	30·25	3·31	0·3025	1·0448	5·302	1·300	2·870	1·078	2·100	0·947	1·498	0·802	50
55	4·33	30·41	3·29	0·3041	1·0452	5.346	1·298	2·884	1·077	2·107	0·946	1·502	0·801	55
17—0	4·37	30·57	3.27	0·3057	1·0457	5·391	1·295	2·898	1·076	2·115	0·946	1·506	0·801	17—0
5	4·41	30·73	3·25	0·3073	1·0462	5·440	1·294	2·913	1·074	2·123	0·945	1·510	0·800	5
10	4·45	30·89	3·24	0·3089	1·0466	5·489	1·292	2·927	1·073	2·131	0·944	1·515	0·800	10
15	4·50	31·05	3·22	0·3105	1·0471	5·538	1·291	2·941	1·072	2·139	0·943	1·519	0·799	15
20	4·54	31·21	3·21	0·3121	1·0476	5·587	1·289	2·956	1·070	2·146	0·942	1·523	0·799	20
25	4·58	31·37	3·19	0·3137	1·0480	5·636	1·288	2·971	1·069	2·154	0·942	1·528	0·798	25
30	4·63	31·53	3·17	0·3153	1·0485	5·686	1·286	2·986	1·068	2·162	0·941	1·532	0·798	30
35	4·67	31·69	3·16	0·3169	1·0490	5·741	1·285	3·001	1·066	2·170	0·940	1·536	0·797	35
40	4·72	31·85	3·14	0·3185	1·0495	5·796	1·283	3·016	1·065	2·179	0·939	1·541	0·797	40
45	4·76	32·01	3·13	0·3201	1·0500	5·851	1·281	3·031	1·064	2·187	0·938	1·545	0·796	45
50	4·80	32·17	3·11	0·3217	1·0505	5·906	1·279	3·046	1·063	2·195	0·937	1·549	0·795	50
55	4·85	32·33	3·09	0·3233	1·0510	5·961	1·277	3·062	1·061	2·204	0·935	1·554	0·795	55
18—0	4·90	32·49	3·08	0·3249	1·0515	6·016	1·275	3·078	1·060	2·212	0·934	1·558	0·794	18—0
5	4·94	32·65	3·06	0·3265	1·0520	6·078	1·274	3·094	1·059	2·221	0·933	1·563	0·793	5
10	4·98	32·81	3·05	0·3281	1·0525	6·140	1·272	3·110	1·058	2·230	0·933	1·567	0·792	10

15	5·03	32·98	3·03	0·3298	1·0530	6·202	1·270	3·126	1·057	2·238	0·932	1·572	0·792	15
20	5·08	33·14	3·02	0·3314	1·0535	6·264	1·268	3·144	1·056	2·247	0·931	1·576	0·791	20
25	5·12	33·30	3·00	0·3330	1·0540	6·326	1·266	3·161	1·055	2·256	0·930	1·581	0·791	25
30	5·17	33·46	2·99	0·3346	1·0545	6·387	1·264	3·178	1·054	2·265	0·930	1·586	0·790	30
35	5·21	33·62	2·98	0·3362	1·0550	6·457	1·263	3·195	1·053	2·274	0·929	1·590	0·790	35
40	5·26	33·78	2·96	0·3378	1·0555	6·527	1·261	3·212	1·051	2·283	0·928	1·595	0·789	40
45	5·31	33·94	2·95	0·3394	1·0560	6·597	1·259	3·229	1·050	2·292	0·927	1·599	0·788	45
50	5·35	34·11	2·93	0·3411	1·0566	6·667	1·257	3·247	1·049	2·301	0·926	1·604	0·788	50
55	5·40	34·27	2·92	0·3427	1·0571	6·738	1·255	3·265	1·048	2·310	0·925	1·607	0·787	55
19—0	5·45	34·43	2·90	0·3443	1·0576	6·808	1·253	3·283	1·047	2·319	0·924	1·613	0·787	19—0
5	5·50	34·59	2·89	0·3459	1·0581	6·888	1·252	3·301	1·046	2·329	0·924	1·618	0·786	5
10	5·54	34·76	2·88	0·3476	1·0587	6·968	1·250	3·319	1·044	2·339	0·923	1·623	0·786	10
15	5·59	34·92	2·86	0·3492	1·0592	7·048	1·248	3·338	1·043	2·349	0·922	1·628	0·785	15
20	5·64	35·08	2·85	0·3508	1·0598	7·128	1·246	3·357	1·042	2·359	0·921	1·633	0·785	20
25	5·69	35·25	2·83	0·3525	1·0603	7·209	1·244	3·376	1·040	2·368	0·920	1·638	0·784	25
30	5·74	35·41	2·82	0·3541	1·0608	7·290	1·242	3·396	1·039	2·378	0·920	1·643	0·783	30
35	5·78	35·57	2·81	0·3557	1·0614	7·382	1·240	3·416	1·038	2·388	0·919	1·648	0·783	35
40	5·83	35·74	2·80	0·3574	1·0619	7·474	1·238	3·436	1·037	2·398	0·918	1·653	0·782	40
45	5·88	35·90	2·79	0·3590	1·0625	7·566	1·236	3·456	1·035	2·408	0·917	1·658	0·782	45
50	5·93	36·07	2·77	0·3607	1·0631	7·658	1·235	3·476	1·034	2·418	0·916	1·663	0·781	50
55	5·98	36·23	2·76	0·3623	1·0636	7·750	1·233	3·496	1·033	2·428	0·915	1·668	0·781	55
20—0	6·03	36·40	2·75	0·3640	1·0642	7·842	1·232	3·517	1·032	2·439	0·914	1·673	0·780	20—0
5	6·08	36·56	2·74	0·3656	1·0647	7·944	1·230	3·538	1·031	2·449	0·914	1·678	0·780	5
10	6·13	36·73	2·72	0·3673	1·0653	8·047	1·228	3·560	1·030	2·460	0·913	1·684	0·779	10
15	6·18	36·89	2·71	0·3689	1·0659	8·150	1·226	3·582	1·029	2·471	0·912	1·689	0·779	15
20	6·23	37·06	2·70	0·3706	1·0665	8·262	1·225	3·604	1·028	2·482	0·912	1·695	0·778	20
25	6·28	37·22	2·69	0·3722	1·0670	8·374	1·223	3·626	1·027	2·493	0·911	1·700	0·778	25
30	6·33	37·39	2·68	0·3739	1·0676	8·487	1·222	3·649	1·026	2·504	0·910	1·705	0·777	30
35	6·38	37·55	2·66	0·3755	1·0682	8·608	1·220	3·672	1·025	2·515	0·909	1·711	0·777	35
40	6·44	37·72	2·65	0·3772	1·0688	8·729	1·218	3·695	1·023	2·527	0·909	1·716	0·776	40
45	6·48	37·89	2·64	0·3789	1·0694	8·851	1·216	3·718	1·022	2·538	0·908	1·722	0·776	45
50	6·54	38·05	2·63	0·3805	1·0699	8·983	1·215	3·742	1·021	2·549	0·907	1·727	0·775	50
55	6·59	38·22	2·62	0·3822	1·0705	9·116	1·213	3·766	1·020	2·561	0·906	1·732	0·775	55

TABLE I.

Angles of Elevation and Depression	Reduction for Chainage	Rise or Fall per Hundred Horizontal	Ratio of Inclination	Rise or Fall per Unit Horizontal	SETTING OUT HALF-WIDTHS									Angles of Elevation and Depression
					Coefficient for Formation	2 to 1		1½ to 1		1¼ to 1		1 to 1		
						Major Coefficient	Minor Coefficient	Major Coefficient	Minor Coefficient	Major Coefficient	Minor Coefficient	Major Coefficient	Minor Coefficient	
21°–0′	6·64	38·38	2·60	0·3838	1·0711	9·249	1·212	3·790	1·019	2·573	0·905	1·738	0·774	21°–0′
5	6·69	38·55	2·59	0·3855	1·0717	9·349	1·211	3·815	1·018	2·585	0·904	1·744	0·774	5
10	6·74	38·72	2·58	0·3872	1·0723	9·539	1·209	3·840	1·017	2·597	0·903	1·750	0·773	10
15	6·80	38·89	2·57	0·3889	1·0730	9·684	1·208	3·865	1·016	2·609	0·902	1·756	0·773	15
20	6·85	39·05	2·56	0·3905	1·0736	9·843	1·206	3·891	1·015	2·622	0·901	1·762	0·772	20
25	6·90	39·22	2·55	0·3922	1·0742	10·003	1·205	3·917	1·014	2·634	0·900	1·767	0·772	25
30	6·96	39·39	2·54	0·3939	1·0748	10·163	1·203	3·943	1·013	2·646	0·900	1·773	0·771	30
35	7·01	39·56	2·53	0·3956	1·0754	10·338	1·202	3·970	1·012	2·658	0·899	1·779	0·771	35
40	7·07	39·73	2·52	0·3973	1·0760	10·514	1·200	3·997	1·011	2·671	0·898	1·785	0·770	40
45	7·12	39·89	2·51	0·3989	1·0766	10·690	1·199	4·024	1·010	2·683	0·898	1·791	0·770	45
50	7·17	40·06	2·50	0·4006	1·0773	10·885	1·197	4·052	1·009	2·696	0·897	1·796	0·769	50
55	7·23	40·23	2·48	0·4023	1·0779	11·080	1·196	4·080	1·008	2·709	0·896	1·803	0·769	55
22 – 0	7·28	40·40	2·47	0·4040	1·0785	11·276	1·194	4·109	1·007	2·722	0·896	1·809	0·768	22 – 0
5	7·34	40·57	2·46	0·4057	1·0792			4·138	1·006	2·735	0·895	1·816	0·768	5
10	7·39	40·74	2·45	0·4074	1·0798			4·168	1·006	2·749	0·894	1·822	0·767	10
15	7·45	40·91	2·44	0·4091	1·0804			4·198	1·005	2·763	0·893	1·829	0·767	15
20	7·50	41·08	2·43	0·4108	1·0811			4·229	1·004	2·777	0·892	1·835	0·766	20
25	7·56	41·25	2·42	0·4125	1·0817			4·260	1·003	2·791	0·891	1·842	0·766	25
30	7·61	41·42	2·41	0·4142	1·0824			4·291	1·002	2·805	0·890	1·849	0·765	30
35	7·67	41·59	2·40	0·4159	1·0830			4·323	1·001	2·819	0·889	1·855	0·765	35
40	7·72	41·76	2·39	0·4176	1·0837			4·355	1·000	2·833	0·889	1·862	0·764	40
45	7·78	41·93	2·38	0·4193	1·0844			4·387	0·999	2·847	0·889	1·868	0·764	45
50	7·84	42·11	2·37	0·4211	1·0850			4·420	0·998	2·861	0·888	1·875	0·763	50
55	7·89	42·28	2·36	0·4228	1·0857			4·454	0·997	2·876	0·888	1·881	0·763	55
23 – 0	7·95	42·45	2·36	0·4245	1·0864			4·488	0·996	2·891	0·887	1·888	0·763	23 – 0
5	8·01	42·62	2·35	0·4262	1·0870			4·523	0·995	2·906	0·886	1·895	0·762	5
10	8·06	42·79	2·34	0·4279	1·0877			4·559	0·994	2·921	0·885	1·902	0·762	10

15	[illegible]	[illegible]	2·33	0·4296	1·0884			4·595	0·993	2·937	0·885	1·909	0·761	15
20	8·18	43·14	2·32	0·4314	1·0891			4·632	0·992	2·953	0·884	1·916	0·761	20
25	8·24	43·31	2·31	0·4331	1·0898			4·669	0·991	2·969	0·883	1·923	0·760	25
30	8·29	43·48	2·30	0·4348	1·0904			4·706	0·990	2·985	0·883	1·930	0·760	30
35	8·35	43·65	2·29	0·4365	1·0911			4·745	0·989	3·001	0·882	1·937	0·760	35
40	8·41	43·82	2·28	0·4382	1·0918			4·784	0·988	3·017	0·881	1·944	0·759	40
45	8·47	44·00	2·27	0·4400	1·0925			4·824	0·987	3·033	0·880	1·951	0·759	45
50	8·53	44·17	2·26	0·4417	1·0932			4·865	0·986	3·050	0·880	1·958	0·758	50
55	8·59	44·35	2·25	0·4435	1·0939			4·906	0·985	3·067	0·879	1·966	0·758	55
24—0	8·65	44·52	2·24	0·4452	1·0946			4·947	0·985	3·084	0·879	1·973	0·757	24—0
5	8·70	44·70	2·24	0·4470	1·0953			4·990	0·984	3·101	0·878	1·980	0·757	5
10	8·76	44·87	2·23	0·4487	1·0961			5·033	0·983	3·118	0·877	1·987	0·757	10
15	8·82	45·04	2·22	0·4504	1·0968			5·077	0·982	3·136	0·876	1·994	0·756	15
20	8·88	45·22	2·21	0·4522	1·0975			5·122	0·981	3·154	0·875	2·001	0·756	20
25	8·94	45·40	2·20	0·4540	1·0982			5·168	0·980	3·172	0·874	2·011	0·755	25
30	9·00	45·57	2·19	0·4557	1·0989			5·214	0·979	3·190	0·874	2·026	0·755	30
35	9·06	45·74	2·18	0·4574	1·0997			5·262	0·978	3·209	0·873	2·033	0·754	35
40	9·12	45·92	2·18	0·4592	1·1004			5·310	0·977	3·228	9·872	2·040	0·754	40
45	9·19	46·10	2·17	0·4610	1·1011			5·358	0·977	3·247	0·871	2·047	0·754	45
50	9·25	46·28	2·16	0·4628	1·1019			5·409	0·976	3·266	0·871	2·054	0·753	50
55	9·31	46·45	2·15	0·4645	1·1026			5·460	0·976	3·285	0·870	2·061	0·753	55
25—0	9·37	46·63	2·14	0·4663	1·1034			5·512	0·975	3·305	0·870	2·067	0·753	25—0
5	9·43	46·81	2·14	0·4681	1·1041			5·566	0·974	3·325	0·869	2·076	0·752	5
10	9·49	46·99	2·13	0·4699	1·1049			5·620	0·973	3·345	0·868	2·084	0·752	10
15	9·55	47·16	2·12	0·4716	1·1056			5·674	0·972	3·365	0·867	2·093	0·751	15
20	9·62	47·34	2·11	0·4734	1·1063			5·731	0·971	3·386	0·867	2·102	0·751	20
25	9·68	47·52	2·10	0·4752	1·1072			5·788	0·970	3·407	0·867	2·110	0·751	25
30	9·74	47·70	2·10	0·4770	1·1079			5·846	0·969	3·428	0·866	2·119	0·750	30
35	9·80	47·88	2·09	0·4788	1·1087			5·906	0·968	3·449	0·866	2·128	0·750	35
40	9·87	48·06	2·08	0·4806	1·1095			5·967	0·967	3·471	0·865	2·136	0·749	40
45	9·93	48·23	2·07	0·4823	1·1102			6·028	0·966	3·493	0·865	2·145	0·749	45
50	9·99	48·42	2·06	0·4842	1·1110			6·097	0·965	3·516	0·865	2·155	0·749	50
55	10·06	48·59	2·06	0·4859	1·1118			6·158	0·965	3·539	0·864	2·163	0·748	55

TABLE I.

Angles of Elevation and Depression	Reduction for Chainage	Rise or Fall per Hundred Horizontal	Ratio of Inclination	Rise or Fall per Unit Horizontal	SETTING OUT HALF-WIDTHS					Angles of Elevation and Depression.
					Coefficient for Formation	1¼ to 1		1 to 1		
						Major Coefficient	Minor Coefficient	Major Coefficient	Minor Coefficient	
26°—0′	10·13	48·77	2·05	0·4877	1·1126	3·562	0·864	2·172	0·748	26°—0′
5	10·18	48·95	2·04	0·4895	1·1134	3·585	0·863	2·182	0·747	5
10	10·25	49·14	2·03	0·4914	1·1142	3·608	0·863	2·191	0·747	10
15	10·31	49·32	2·03	0·4932	1·1150	3·631	0·862	2·201	0·747	15
20	10·38	49·49	2·02	0·4949	1·1158	3·655	0·862	2·210	0·746	20
25	10·44	49·68	2·01	0·4968	1·1166	3·680	0·861	2·220	0·746	25
30	10·51	49·86	2·01	0·4986	1·1174	3·705	0·860	2·230	0·746	30
35	10·57	50·04	2·00	0·5004	1·1182	3·730	0·859	2·239	0·745	35
40	10·64	50·22	1·99	0·5022	1·1190	3·755	0·859	2·249	0·745	40
45	10·70	50·41	1·98	0·5041	1·1198	3·781	0·858	2·258	0·745	45
50	10·77	50·59	1·98	0·5059	1·1207	3·807	0·858	2·268	0·744	50
55	10·83	50·77	1·97	0·5077	1·1215	3·834	0·857	2·278	0·744	55
27—0	10·90	50·95	1.96	0·5095	1·1223	3·861	0·857	2·288	0·744	27—0
5	10·96	51·13	1·96	0·5113	1·1232	3·889	0·856	2·298	0·743	5
10	11·03	51·32	1·95	0·5132	1·1240	3·917	0·855	2·309	0·743	10
15	11·10	51·50	1·94	0·5150	1·1248	3·945	0·855	2·320	0·742	15
20	11·16	51·69	1·93	0·5169	1·1257	3·973	0·854	2·331	0·742	20
25	11·23	51·87	1·93	0·5187	1·1265	4·002	0·854	2·342	0·742	25
30	11·30	52·06	1·92	0·5206	1·1274	4·032	0·853	2·353	0·741	30
35	11·37	52·24	1·91	0·5224	1·1282	4·062	0·853	2·364	0·741	35
40	11·43	52·43	1·91	0·5243	1·1291	4·092	0·852	2·374	0·741	40
45	11·50	52·61	1·90	0·5261	1·1300	4·123	0·852	2·385	0·740	45
50	11·57	52·80	1·89	0·5280	1·1308	4·155	0·852	2·396	0·740	50
55	11·64	52·99	1·89	0·5299	1·1317	4·187	0·851	2·407	0·740	55
28—0	11·71	53·17	1·88	0·5317	1·1326	4·219	0·851	2·418	0·739	28—0
5	11·77	53·35	1·87	0·5335	1·1334	4·253	0·850	2·430	0·739	5

15	11·91	53·73	1·8[illegible]	0·5373	1·1352	4·321	0·849	2·455	0·738	15
20	11·98	53·92	1·85	0·5392	1·1361	4 355	0·849	2·467	0·738	20
25	12·05	54·11	1·85	0·5411	1·1370	4·390	0·848	2·479	0·738	25
30	12·12	54·30	1·84	0·5430	1·1379	4·425	0·848	2·491	0·737	30
35	12·19	54·48	1·84	0·5448	1·1388	4·461	0·847	2·503	0·737	35
40	12·26	54·67	1·83	0·5467	1·1397	4·497	0·846	2·516	0·737	40
45	12·33	54·86	1·82	0·5486	1·1406	4·535	0·845	2·528	0·736	45
50	12·40	55·05	1·82	0·5505	1·1415	4·573	0·845	2·540	0·736	50
55	12·47	55·24	1·81	0·5524	1·1424	4·611	0·844	2·553	0·736	55
29—0	12·54	55·43	1·80	0·5543	1·1434	4·649	0·844	2·565	0·736	29—0
5	12·61	55·62	1·80	0·5562	1·1443	4·690	0·843	2·579	0·735	5
10	12·68	55·81	1·79	0·5581	1·1452	4·731	0·843	2·593	0·735	10
15	12·75	56·01	1·79	0·5601	1·1461	4·772	0·842	2·607	0·735	15
20	12·82	56·20	1·78	0·5620	1·1471	4·814	0·842	2·621	0·734	20
25	12·89	56·40	1·77	0·5640	1·1480	4·858	0·841	2·635	0·734	25
30	12·97	56·58	1·77	0·5658	1·1490	4·902	0·841	2·648	0·734	30
35	13·04	56·77	1·76	0·5677	1·1499	4·946	0·840	2·662	0·733	35
40	13·11	56·96	1·76	0·5696	1·1509	4·991	0·839	2·676	0·733	40
45	13·18	57·15	1·75	0·5715	1·1518	5·038	0·838	2·690	0·733	45
50	13·25	57·35	1·74	0·5735	1·1528	5·085	0·838	2·704	0·733	50
55	13·32	57·54	1·74	0·5754	1·1537	5·133	0·837	2·718	0·732	55
30—0	13·40	57·74	1·73	0·5774	1·1547	5·181	0·837	2·732	0·732	30—0
5	13·47	57·93	1·73	0·5793	1·1557	5·232	0·836	2·747	0·732	5
10	13·54	58·12	1·72	0·5812	1·1566	5·283	0·836	2·763	0·731	10
15	13·62	58·32	1·72	0·5832	1·1576	5·335	0·836	2·778	0·731	15
20	13·69	58·51	1·71	0·5851	1·1586	5·387	0·835	2·793	0·731	20
25	13·76	58·70	1·71	0·5870	1·1596	5·442	0·835	2·808	0·731	25
30	13·84	58·90	1·70	0·5890	1·1606	5·498	0·835	2·824	0·730	30
35	13·91	59·09	1·69	0·5909	1·1616	5·554	0·834	2·840	0·730	35
40	13·99	59·29	1·68	0·5929	1·1626	5·610	0·834	2·857	0·730	40
45	14·06	59·48	1·68	0·5948	1·1636	5·670	0·834	2·873	0·730	45
50	14·13	59·67	1·67	0·5967	1·1646	5·730	0·833	2·890	0·729	50
55	14·21	59·88	1·67	0·5988	1·1656	5·791	0·833	2·906	0·729	55

TABLE I.

Angles of Elevation and Depression	Reduction for Chainage	Rise or Fall per Hundred Horizontal	Ratio of Inclination	Rise or Fall per Unit Horizontal	SETTING OUT HALF-WIDTHS					Angles of Elevation and Depression.
					Coefficient for Formation	1¼ to 1		1 to 1		
						Major Coefficient	Minor Coefficient	Major Coefficient	Minor Coefficient	
31°—0′	14·28	60·08	1·66	0·6008	1·1666	5·852	0·833	2·923	0·729	31°—0′
5	14·36	60·29	1·66	0·6029	1·1677	5·918	0·832	2·941	0·728	5
10	14·43	60·49	1·65	0·6049	1·1687	5·984	0·832	2·958	0·728	10
15	14·51	60·69	1·65	0·6069	1·1697	6·050	0·831	2·976	0·728	15
20	14·58	60·89	1·64	0·6089	1·1707	6·117	0·831	2·994	0·728	20
25	14·66	61·09	1·64	0·6109	1·1718	6·189	0·830	3·011	0·727	25
30	14·74	61·28	1·63	0·6128	1·1728	6·261	0·830	3·029	0·727	30
35	14·81	61·48	1·63	0·6148	1·1739	6·333	0·829	3·048	0·727	35
40	14·89	61·68	1·62	0·6168	1·1749	6·406	0·829	3·067	0·727	40
45	14·96	61·88	1·61	0·6188	1·1760	6·485	0·828	3·086	0·726	45
50	15·04	62·08	1·61	0·6208	1·1770	6·565	0·828	3·105	0·726	50
55	15·12	62·29	1·60	0·6229	1·1781	6·645	0·827	3·124	0·726	55
32—0	15·20	62·49	1·60	0·6249	1·1792	6·725	0·827	3·143	0·726	32—0
5	15·27	62·69	1.59	0·6269	1·1803	6·813	0·827	3·165	0·725	5
10	15·35	62·90	1·59	0·6290	1·1813	6·901	0·826	3·188	0·725	10
15	15·43	63·10	1·59	0·6310	1·1824	6·989	0·826	3·210	0·725	15
20	15·50	63·30	1·58	0·6330	1·1835	7·078	0·825	3·232	0·725	20
25	15·58	63·51	1·58	0·6351	1·1846	7·175	0·825	3·254	0·725	25
30	15·66	63·72	1·57	0·6372	1·1857	7·273	0·824	3·277	0·724	30
35	15·74	63·92	1·56	0·6392	1·1868	7·371	0·824	3·298	0·724	35
40	15·82	64·12	1·56	0·6412	1·1879	7·469	0·823	3·318	0·724	40
45	15·90	64·32	1·56	0·6432	1·1890	7·578	0·823	3·339	0·724	45
50	15·97	64·52	1·55	0·6452	1·1901	7·687	0·822	3·360	0·723	50
55	16·05	64·73	1·55	0·6473	1·1912	7·797	0·822	3·380	0·723	55
33—0	16·13	64·94	1·54	0·6494	1·1923	7·907	0·822	3·401	0·723	33—0
5	16·21	65·15	1·54	0·6515	1·1935	8·034	0·822	3·426	0·723	5
10	16·29	65·35	1·53	0·6535	1·1946	8·161	0·821	3·451	0·722	10

15	16·37	65·56	1·53	0·6556	1·1958	8·288	0·821	3·470	0·722	15
20	16·45	65·77	1·52	0·6577	1·1969	8·415	0·821	3·501	0·722	20
25	16·53	65·98	1·52	0·6598	1·1980	8·542	0·820	3·526	0·722	25
30	16·61	66·20	1·51	0·6620	1·1992	8·670	0·820	3·552	0·722	30
35	16·69	66·40	1·51	0·6640	1·2004	8·824	0·820	3·578	0·721	35
40	16·77	66·61	1·50	0·6661	1·2015	8·978	0·819	3·604	0·721	40
45	16·85	66·82	1·50	0·6682	1·2027	9·132	0·819	3·629	0·721	45
50	16·93	67·02	1·49	0·6702	1·2038	9·286	0·819	3·655	0·721	50
55	17·02	67·24	1·49	0·6724	1·2050	9·440	0·818	3·681	0·721	55
34—0	17·10	67·45	1·48	0·6745	1·2062	9·595	0·818	3·706	0·720	34—0
5	17·18	67·67	1·48	0·6767	1·2074	9·787	0·818	3·735	0·720	5
10	17·26	67·88	1·47	0·6788	1·2086	9·979	0·817	3·764	0·720	10
15	17·34	68·09	1·47	0·6809	1·2097	10·171	0·817	3·793	0·720	15
20	17·42	68·31	1·46	0·6831	1·2110	10·363	0·816	3·822	0·720	20
25	17·50	68·52	1·46	0·6852	1·2122	10·554	0·816	3·851	0·719	25
30	17·59	68·73	1·46	0·6873	1·2134	10·745	0·816	3·880	0·719	30
35	17·67	68·95	1·45	0·6895	1·2146	10·990	0·815	3·912	0·719	35
40	17·75	69·16	1·45	0·6916	1·2158	11·234	0·815	3·944	0·719	40
45	17·83	69·37	1·44	0·6937	1·2171	11·478	0·815	3·976	0·719	45
50	17·92	69·59	1·44	0·6959	1·2183	11·722	0·814	4·008	0·718	50
55	18·00	69·80	1·43	0·6980	1·2195	11·966	0·814	4·040	0·718	55
35—0	18·08	70·02	1·43	0·7002	1·2208	12·209	0·814	4·072	0·718	35—0
5	18·17	70·24	1·42	0·7024	1·2220			4·107	0·718	5
10	18·25	70·46	1·42	0·7046	1·2233			4·143	0·718	10
15	18·34	70·67	1·42	0·7067	1·2245			4·178	0·717	15
20	18·42	70·89	1·41	0·7089	1·2258			4·213	0·717	20
25	18·50	71·11	1·41	0·7111	1·2271			4·248	0·717	25
30	18·59	71·33	1·40	0·7133	1·2283			4·284	0·717	30
35	18·67	71·55	1·40	0·7155	1·2296			4·323	0·717	35
40	18·76	71·77	1·39	0·7177	1·2308			4·363	0·717	40
45	18·84	71·99	1·39	0·7199	1·2322			4·402	0·716	45
50	18·93	72·31	1·39	0·7231	1·2335			4·441	0·716	50
55	19·01	72·43	1·38	0·7243	1·2348			4·480	0·716	55

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

0° 0′	Cosines	60′
0	·00000	60′
1	·00000	59
2	·99999	58
3	·99999	57
4	·99999	56
5	·99999	55
6	·99999	54
7	·99999	53
8	·99999	52
9	·99999	51
10	·99999	50
11	·99999	49
12	·99999	48
13	·99999	47
14	·99999	46
15	·99999	45
16	·99999	44
17	·99999	43
18	·99999	42
19	·99998	41
20	·99998	40
21	·99998	39
22	·99998	38
23	·99998	37
24	·99997	36
25	·99997	35
26	·99997	34
27	·99997	33
28	·99997	32
29	·99996	31
30	·99996	30
31	·99996	29
32	·99996	28
33	·99995	27
34	·99995	26
35	·99995	25
36	·99994	24
37	·99994	23
38	·99994	22
39	·99993	21
40	·99993	20
41	·99993	19
42	·99992	18
43	·99992	17
44	·99992	16
45	·99991	15
46	·99991	14
47	·99991	13
48	·99990	12
49	·99990	11
50	·99989	10
51	·99989	9
52	·99988	8
53	·99988	7
54	·99988	6
55	·99987	5
56	·99987	4
57	·99986	3
58	·99986	2
59	·99985	1
60	·99985	0 ·89
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

0 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
0° 0′	9·999	19·999	29·999	39·999	49·999	59·999	69·999	79·999	89·999	99·999	60′
5	9·999	19·999	29·999	39·999	49·999	59·999	69·999	79·999	89·999	99·999	55
10	9·999	19·999	29·999	39·999	49·999	59·999	69·999	79·999	89·999	99·999	50
15	9·999	19·999	29·999	39·999	49·999	59·999	69·999	79·999	89·999	99·999	45
20	9·999	19·999	29·999	39·999	49·999	59·999	69·999	79·999	89·999	99·999	40
25	9·999	19·999	29·999	39·999	49·999	59·999	69·999	79·999	89·999	99·999	35
30	9·999	19·999	29·999	39·999	49·999	59·999	69·999	79·999	89·999	99·999	30
35	9·999	19·999	29·999	39·999	49·999	59·999	69·999	79·999	89·999	99·999	25
40	9·999	19·999	29·999	39·999	49·999	59·999	69·999	79·999	89·999	99·999	20
45	9·999	19·999	29·999	39·999	49·999	59·999	69·999	79·999	89·999	99·999	15
50	9·999	19·998	29·997	39·998	49·994	59·993	69·992	79·991	89·990	99·989	10
55	9·999	19·997	29·996	39·995	49·993	59·992	69·991	79·990	89·988	99·987	5
60	9·998	19·997	29·995	39·994	49·992	59·991	69·989	79·988	89·986	99·985	89° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

89 Deg. Departures, or Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

TABLE II.

Departures, or Difference of Levels

0° 0'	Sines	60'
1	·00029	59
2	·00058	58
3	·00087	57
4	·00116	56
5	·00145	55
6	·00174	54
7	·00204	53
8	·00233	52
9	·00262	51
10	·00291	50
11	·00320	49
12	·00349	48
13	·00378	47
14	·00407	46
15	·00436	45
16	·00465	44
17	·00494	43
18	·00524	42
19	·00553	41
20	·00582	40
21	·00611	39
22	·00640	38
23	·00669	37
24	·00698	36
25	·00727	35
26	·00756	34
27	·00785	33
28	·00814	32
29	·00843	31
30	·00873	30
31	·00902	29
32	·00931	28
33	·00960	27
34	·00989	26
35	·01018	25
36	·01047	24
37	·01076	23
38	·01105	22
39	·01134	21
40	·01163	20
41	·01193	19
42	·01222	18
43	·01251	17
44	·01280	16
45	·01309	15
46	·01338	14
47	·01367	13
48	·01396	12
49	·01425	11
50	·01454	10
51	·01483	9
52	·01512	8
53	·01542	7
54	·01571	6
55	·01600	5
56	·01629	4
57	·01658	3
58	·01687	2
59	·01716	1
60	·01745	0·89
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

0 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
0° 0'	0·000	0·000	0·000	0 000	0·000	0·000	0·000	0·000	0·000	0·000	60'
5	0·014	0·029	0·044	0·058	0·072	0·087	0·101	0·116	0·130	0·145	55
10	0·029	0·058	0·087	0·116	0·145	0·175	0·204	0·233	0·262	0·291	50
15	0·044	0·087	0·131	0·174	0·218	0·262	0·305	0·349	0·392	0·436	45
20	0·058	0·116	0·175	0·233	0·291	0·349	0·407	0·466	0·524	0·582	40
25	0·072	0·145	0·218	0·291	0·363	0·436	0·509	0·582	0·654	0·727	35
30	0·087	0·175	0·262	0·349	0·436	0·524	0·611	0·698	0·786	0·873	30
35	0·102	0·204	0·305	0·407	0·509	0·611	0·713	0·814	0·916	1·018	25
40	0·116	0·233	0·349	0·465	0·581	0·698	0·814	0·930	1·047	1·163	20
45	0·131	0·262	0·393	0·524	0·654	0·785	0·916	1·047	1·178	1·309	15
50	0·145	0·291	0·436	0·582	0·727	0·872	1·018	1·163	1·309	1·454	10
55	0·160	0·320	0·480	0·640	0·800	0·960	1·120	1·280	1·440	1·600	5
60	0·174	0·349	0·524	0·698	0·873	1·047	1·222	1·396	1·571	1·745	89° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

89 Deg. Latitudes, or Horizontal Distances for Difference of Levels.

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
1° 0′	·99985	60′
1	·99984	59
2	·99984	58
3	·99983	57
4	·99983	56
5	·99982	55
6	·99981	54
7	·99981	53
8	·99980	52
9	·99980	51
10	·99979	50
11	·99979	49
12	·99978	48
13	·99977	47
14	·99977	46
15	·99976	45
16	·99975	44
17	·99975	43
18	·99974	42
19	·99974	41
20	·99973	40
21	·99972	39
22	·99971	38
23	·99971	37
24	·99970	36
25	·99970	35
26	·99969	34
27	·99968	33
28	·99967	32
29	·99966	31
30	·99966	30
31	·99965	29
32	·99964	28
33	·99963	27
34	·99963	26
35	·99962	25
36	·99961	24
37	·99960	23
38	·99959	22
39	·99958	21
40	·99958	20
41	·99957	19
42	·99956	18
43	·99955	17
44	·99954	16
45	·99953	15
46	·99952	14
47	·99951	13
48	·99951	12
49	·99950	11
50	·99949	10
51	·99948	9
52	·99947	8
53	·99946	7
54	·99945	6
55	·99944	5
56	·99943	4
57	·99942	3
58	·99941	2
59	·99940	1
60	·99939	0 ·88
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

1 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
1° 0′	9·998	19·997	29·995	39·994	49·992	59·991	69·989	79·988	89·986	99·985	60′
5	9·998	19·996	29·995	39·993	49·991	59·989	69·987	79·986	89·984	99·982	55
10	9·998	19·996	29·994	39·992	49·989	59·987	69·985	79·983	89·981	99·979	50
15	9·998	19·995	29·993	39·990	49·988	59·986	69·983	79·981	89·978	99·976	45
20	9·997	19·995	29·992	39·989	49·986	59·984	69·981	79·978	89·976	99·973	40
25	9·997	19·994	29·991	39·988	49·985	59·982	69·979	79·976	89·973	99·970	35
30	9·997	19·993	29·990	39·985	49·982	59·979	69·975	79·972	89·968	99·966	30
35	9·996	19·992	29·989	39·984	49·981	59·977	69·973	79·970	89·966	99·962	25
40	9·996	19·992	29·987	39·983	49·979	59·975	69·970	79·966	89·962	99·958	20
45	9·995	19·991	29·986	39·981	49·976	59·972	69·967	79·962	89·958	99·953	15
50	9·995	19·990	29·985	39·980	49·974	59·969	69·964	79·959	89·954	99·949	10
55	9·994	19·989	29·983	39·978	49·972	59·966	69·961	79·955	89·950	99·944	5
60	9·994	19.988	29·982	39·976	49·969	59·963	69·957	79·951	89·945	99·939	88° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

88 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels	Sines	
1° 0′	·01745	60′
1	·01774	59
2	·01803	58
3	·01832	57
4	·01862	56
5	·01891	55
6	·01919	54
7	·01949	53
8	·01978	52
9	·02007	51
10	·02036	50
11	·02065	49
12	·02094	48
13	·02123	47
14	·02152	46
15	·02181	45
16	·02211	44
17	·02240	43
18	·02269	42
19	·02298	41
20	·02327	40
21	·02356	39
22	·02385	38
23	·02414	37
24	·02443	36
25	·02472	35
26	·02501	34
27	·02530	33
28	·02559	32
29	·02589	31
30	·02618	30
31	·02647	29
32	·02676	28
33	·02705	27
34	·02734	26
35	·02763	25
36	·02792	24
37	·02821	23
38	·02850	22
39	·02879	21
40	·02908	20
41	·02937	19
42	·02967	18
43	·02996	17
44	·03025	16
45	·03054	15
46	·03083	14
47	·03112	13
48	·03141	12
49	·03170	11
50	·03199	10
51	·03228	9
52	·03257	8
53	·03286	7
54	·03315	6
55	·03345	5
56	·03374	4
57	·03403	3
58	·03432	2
59	·03461	1
60	·03490	0 88
	Cosines	
Latitudes, or Horizontal Distances for Difference of Levels		

1 Deg. Departures, or Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
1° 0′	0·174	0·349	0·524	0·698	0·873	1·047	1·222	1·396	1·571	1·745	60′
5	0·189	0·378	0·567	0·756	0·945	1·135	1·324	1·513	1·702	1·891	55
10	0·204	0·407	0·611	0·814	1·018	1·222	1·425	1·629	1·832	2·036	50
15	0·218	0·436	0·654	0·872	1·090	1·309	1·527	1·745	1·963	2·181	45
20	0·233	0·465	0·698	0·931	1·163	1·396	1·629	1·861	2·094	2·327	40
25	0·247	0·494	0·742	0·989	1·236	1·483	1·730	1·978	2·225	2·472	35
30	0·262	0·523	0·785	1·047	1·309	1·571	1·832	2·094	2·356	2·618	30
35	0·276	0·553	0·829	1·105	1·381	1·658	1·934	2·210	2·487	2·763	25
40	0·291	0·582	0·872	1·163	1·454	1·745	2·036	2·327	2·618	2·908	20
45	0·305	0·611	0·916	1·222	1·527	1·832	2·138	2·443	2·749	3·054	15
50	0·320	0·640	0·960	1·280	1·600	1·919	2·239	2·559	2·879	3·199	10
55	0·334	0·669	1·003	1·338	1·672	2·006	2·341	2·675	3·010	3·344	5
60	0·349	0·698	1·047	1·396	1·745	2·094	2·443	2·792	3·141	3·490	88° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

88 Deg. Latitudes, or Horizontal Distances for Difference of Levels

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
2° 0'	·99939	60'
1	·99938	59
2	·99937	58
3	·99936	57
4	·99935	56
5	·99934	55
6	·99933	54
7	·99932	53
8	·99931	52
9	·99930	51
10	·99928	50
11	·99927	49
12	·99926	48
13	·99925	47
14	·99924	46
15	·99923	45
16	·99922	44
17	·99921	43
18	·99920	42
19	·99918	41
20	·99917	40
21	·99916	39
22	·99915	38
23	·99913	37
24	·99912	36
25	·99911	35
26	·99910	34
27	·99909	33
28	·99907	32
29	·99906	31
30	·99905	30
31	·99903	29
32	·99902	28
33	·99901	27
34	·99900	26
35	·99898	25
36	·99897	24
37	·99896	23
38	·99894	22
39	·99893	21
40	·99892	20
41	·99890	19
42	·99889	18
43	·99888	17
44	·99886	16
45	·99885	15
46	·99883	14
47	·99882	13
48	·99881	12
49	·99879	11
50	·99878	10
51	·99876	9
52	·99875	8
53	·99873	7
54	·99872	6
55	·99870	5
56	·99869	4
57	·99867	3
58	·99866	2
59	·99864	1
60	·99863	0·87
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

2 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
2° 0'	9·994	19·988	29·982	39·976	49·969	59·963	69·957	79·951	89·945	99·939	60'
5	9·993	19·987	29·980	39·974	49·967	59·960	69·954	79·947	89·941	99·934	55
10	9·993	19·986	29·978	39·971	49·964	59·957	69·950	79·942	89·935	99·928	50
15	9·992	19·985	29·977	39·969	49·961	59·954	69·946	79·938	89·931	99·923	45
20	9·992	19·983	29·975	39·967	49·958	59·950	69·942	79·934	89·925	99·917	40
25	9·991	19·982	29·973	39·964	49·955	59·947	69·938	79·929	89·920	99·911	35
30	9·990	19·981	29·971	39·962	49·952	59·943	69·933	79·924	89·914	99·905	30
35	9·990	19·980	29·969	39·959	49·949	59·938	69·929	79·918	89·908	99·898	25
40	9·989	19·978	29·967	39·957	49·946	59·935	69·924	79·914	89·903	99·892	20
45	9·988	19·977	29·965	39·954	49·942	59·931	69·919	79·908	89·896	99·885	15
50	9·988	19·976	29·963	39·951	49·939	59·927	69·915	79·902	89·891	99·878	10
55	9·987	19·974	29·961	39·948	49·935	59·922	69·909	79·896	89·883	99·870	5
60	9·986	19·973	29·959	39·945	49·931	59·918	69·904	79·890	89·876	99·863	0 87°
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

87 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels	Sines	
2° 0′	·03490	60′
1	·03519	59
2	·03548	58
3	·03577	57
4	·03606	56
5	·03635	55
6	·03664	54
7	·03693	53
8	·03722	52
9	·03751	51
10	·03781	50
11	·03810	49
12	·03839	48
13	·03868	47
14	·03897	46
15	·03926	45
16	·03955	44
17	·03984	43
18	·04013	42
19	·04042	41
20	·04071	40
21	·04100	39
22	·04129	38
23	·04158	37
24	·04187	36
25	·04216	35
26	·04246	34
27	·04275	33
28	·04304	32
29	·04333	31
30	·04362	30
31	·04391	29
32	·04420	28
33	·04449	27
34	·04478	26
35	·04507	25
36	·04536	24
37	·04565	23
38	·04594	22
39	·04623	21
40	·04652	20
41	·04682	19
42	·04711	18
43	·04740	17
44	·04769	16
45	·04798	15
46	·04827	14
47	·04856	13
48	·04885	12
49	·04914	11
50	·04943	10
51	·04972	9
52	·05001	8
53	·05030	7
54	·05059	6
55	·05088	5
56	·05117	4
57	·05146	3
58	·05175	2
59	·05204	1
60	·05234	0° 87
	C sines	
Latitudes, or Horizontal Distances for Difference of Levels		

DEPARTURES, OR DIFFERENCE OF LEVELS

2 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
2° 0′	0·349	0·698	1·047	1·396	1·745	2·094	2·443	2·792	3·141	3·490	60′
5	0·363	0·727	1·090	1·454	1·817	2·181	2·544	2·908	3·271	3·635	55
10	0·378	0·756	1·134	1·512	1·890	2·268	2·646	3·024	3·402	3·781	50
15	0·393	0·785	1·178	1·570	1·963	2·355	2·748	3·141	3·533	3·926	45
20	0·407	0·814	1·221	1·628	2·036	2·443	2·850	3·257	3·664	4·071	40
25	0·422	0·843	1·265	1·687	2·108	2·530	2·952	3·374	3·795	4·217	35
30	0·436	0·872	1·308	1·745	2·181	2·617	3·053	3·490	3·926	4·362	30
35	0·451	0·901	1·352	1·803	2·253	2·704	3·155	3·606	4·056	4·507	25
40	0·465	0·930	1·396	1·861	2·326	2·791	3·257	3·721	4·186	4·651	20
45	0·480	0·960	1·439	1·919	2·399	2·879	3·359	3·838	4·318	4·798	15
50	0·494	0·989	1·483	1·977	2·471	2·966	3·460	3·954	4·449	4·943	10
55	0·509	1·018	1·526	2·035	2·544	3·053	3·562	4·070	4·579	5·088	5
60	0·523	1·047	1·570	2·093	2·617	3·140	3·663	4·187	4·710	5·234	87° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

87 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
3° 0′	·99863	60′
1	·99861	59
2	·99860	58
3	·99858	57
4	·99857	56
5	·99855	55
6	·99854	54
7	·99852	53
8	·99850	52
9	·99849	51
10	·99847	50
11	·99846	49
12	·99844	48
13	·99842	47
14	·99841	46
15	·99839	45
16	·99837	44
17	·99836	43
18	·99834	42
19	·99832	41
20	·99831	40
21	·99829	39
22	·99827	38
23	·99826	37
24	·99824	36
25	·99822	35
26	·99820	34
27	·99819	33
28	·99817	32
29	·99815	31
30	·99813	30
31	·99812	29
32	·99810	28
33	·99808	27
34	·99806	26
35	·99804	25
36	·99803	24
37	·99801	23
38	·99799	22
39	·99797	21
40	·99795	20
41	·99793	19
42	·99792	18
43	·99790	17
44	·99788	16
45	·99786	15
46	·99784	14
47	·99782	13
48	·99780	12
49	·99778	11
50	·99776	10
51	·99774	9
52	·99772	8
53	·99770	7
54	·99768	6
55	·99766	5
56	·99764	4
57	·99762	3
58	·99760	2
59	·99758	1
60	·99756	0·86
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

3 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
3° 0′	9·986	19·973	29·959	39·945	49·931	59·918	69·904	79·890	89·876	99·863	60′
5	9·985	19·971	29·956	39·942	49·927	59·913	69·898	79·884	89·869	99·855	55
10	9·985	19·969	29·954	39·939	49·923	59·908	69·893	79·878	89·862	99·847	50
15	9·984	19·968	29·952	39·936	49·919	59·903	69·887	79·871	89·855	99·839	45
20	9·983	19·966	29·949	39·932	49·915	59·899	69·882	79·865	89·848	99·831	40
25	9·982	19·964	29·947	39·929	49·911	59·893	69·875	79·858	89·840	99·822	35
30	9·981	19·963	29·944	39·925	49·906	59·888	69·869	79·850	89·832	99·813	30
35	9·980	18·961	29·941	39·922	49·902	59·882	69·863	79·843	89·824	99·804	25
40	9·979	19·959	29·938	39·918	49·897	59·877	69·856	79·836	89·815	99·795	20
45	9·979	19·957	29·936	39·914	49·893	59·872	69·850	79·829	89·807	99·786	15
50	9·978	19·955	29·933	39·910	49·888	59·866	69·843	79·821	89·798	99·776	10
55	9·977	19·953	29·930	39·906	49·883	59·860	69·836	79·813	89·789	99·766	5
60	9·976	19·951	29·927	39·902	49·878	59·853	69·829	79·805	89·780	99·756	86° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

86 Deg. Departures, or Difference of Levels.

DEPARTURES, OR DIFFERENCE OF LEVELS

Departures, or Difference of Levels

	Sines	
3° 0′	·05234	60′
1	·05263	59
2	·05292	58
3	·05321	57
4	·05350	56
5	·05379	55
6	·05408	54
7	·05437	53
8	·05466	52
9	·05495	51
10	·05524	50
11	·05553	49
12	·05582	48
13	·05611	47
14	·05640	46
15	·05669	45
16	·05698	44
17	·05727	43
18	·05756	42
19	·05785	41
20	·05814	40
21	·05843	39
22	·05872	38
23	·05902	37
24	·05931	36
25	·05960	35
26	·05989	34
27	·06018	33
28	·06047	32
29	·06076	31
30	·06105	30
31	·06134	29
32	·06163	28
33	·06192	27
34	·06221	26
35	·06250	25
36	·06279	24
37	·06308	23
38	·06337	22
39	·06366	21
40	·06395	20
41	·06424	19
42	·06453	18
43	·06482	17
44	·06511	16
45	·06540	15
46	·06569	14
47	·06598	13
48	·06627	12
49	·06656	11
50	·06685	10
51	·06714	9
52	·06743	8
53	·06772	7
54	·06801	6
55	·06830	5
56	·06859	4
57	·06889	3
58	·06918	2
59	·06946	1
60	·06976	0°86
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

3 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
3° 0′	0·523	1·047	1·570	2·093	2·617	3·140	3·663	4·187	4·710	5·234	60′
5	0·538	1·076	1·614	2·152	2·689	3·227	3·765	4·303	4·841	5·379	55
10	0·552	1·105	1·657	2·210	2·762	3·314	3·867	4·419	4·972	5·524	50
15	0·567	1·134	1·701	2·268	2·834	3·401	3·968	4·535	5·102	5·669	45
20	0·581	1·163	1·744	2·326	2·907	3·489	4·070	4·651	5·233	5·814	40
25	0·596	1·192	1·788	2·384	2·980	3·576	4·172	4·768	5·364	5·960	35
30	0·610	1·221	1·831	2·442	3·052	3·663	4·273	4·884	5·494	6·105	30
35	0·625	1·250	1·875	2·500	3·125	3·750	4·375	5·000	5·625	6·250	25
40	0·639	1·279	1·918	2·558	3·198	3·837	4·477	5·116	5·756	6·395	20
45	0·654	1·308	1·962	2·616	3·270	3·924	4·578	5·232	5·886	6·540	15
50	0·668	1·337	2·006	2·674	3·343	4·011	4·680	5·348	6·017	6·685	10
55	0·683	1·366	2·049	2·732	3·415	4·098	4·781	5·464	6·147	6·830	5
60	0·698	1·395	2·093	2·790	3·488	4·185	4·883	5·580	6·278	6·976	0 86°
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

86 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
4° 0'	·99756	60'
1	·99754	59
2	·99752	58
3	·99750	57
4	·99748	56
5	·99746	55
6	·99744	54
7	·99742	53
8	·99740	52
9	·99738	51
10	·99736	50
11	·99734	49
12	·99731	48
13	·99729	47
14	·99727	46
15	·99725	45
16	·99723	44
17	·99721	43
18	·99718	42
19	·99716	41
20	·99714	40
21	·99712	39
22	·99710	38
23	·99707	37
24	·99705	36
25	·99703	35
26	·99701	34
27	·99698	33
28	·99696	32
29	·99694	31
30	·99692	30
31	·99689	29
32	·99687	28
33	·99685	27
34	·99682	26
35	·99680	25
36	·99678	24
37	·99675	23
38	·99673	22
39	·99671	21
40	·99668	20
41	·99666	19
42	·99664	18
43	·99661	17
44	·99659	16
45	·99656	15
46	·99654	14
47	·99652	13
48	·99649	12
49	·99647	11
50	·99644	10
51	·99642	9
52	·99639	8
53	·99637	7
54	·99634	6
55	·99632	5
56	·99629	4
57	·99627	3
58	·99624	2
59	·99622	1
60	·99619	0 85
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

4 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
4° 0'	9·976	19·951	29·927	39·902	49·878	59·853	69·829	79·805	89·780	99·756	60'
5	9·975	19·949	29·924	39·898	49·873	59·848	69·822	79·797	89·771	99·746	55
10	9·974	19·947	29·920	39·894	49·868	59·842	69·815	79·789	89·762	99·736	50
15	9·972	19·945	29·917	39·890	49·862	59·835	69·807	79·780	89·752	99·725	45
20	9·971	19·943	29·914	39·885	49·857	59·828	69·800	79·771	89·743	99·714	40
25	9·970	19·941	29·911	39·881	49·851	59·822	69·792	79·762	89·733	99·703	35
30	9·969	19·938	29·908	39·877	49·846	59·815	69·784	79·753	89·723	99·692	30
35	9·968	19·936	29·904	39·872	49·840	59·808	69·776	79·744	89·712	99·680	25
40	9·967	19·934	29·900	39·867	49·834	59·801	69·768	79·734	89·701	99·668	20
45	9·966	19·931	29·897	39·862	49·828	59·794	69·759	79·725	89·690	99·656	15
50	9·964	19·929	29·893	39·858	49·822	59·786	69·751	79·715	89·680	99·644	10
55	9·963	19·926	29·890	39·853	49·816	59·779	69·742	79·705	89·669	99·632	5
60	9·962	19·924	29·886	39·848	49·809	59·771	69·733	79·695	89·657	99·619	85° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

85 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
4° 0'	·06976	60'
1	·07005	59
2	·07034	58
3	·07063	57
4	·07092	56
5	·07121	55
6	·07150	54
7	·07179	53
8	·07208	52
9	·07237	51
10	·07266	50
11	·07295	49
12	·07324	48
13	·07353	47
14	·07382	46
15	·07411	45
16	·07440	44
17	·07469	43
18	·07498	42
19	·07527	41
20	·07556	40
21	·07585	39
22	·07614	38
23	·07643	37
24	·07672	36
25	·07701	35
26	·07730	34
27	·07759	33
28	·07788	32
29	·07817	31
30	·07846	30
31	·07875	29
32	·07904	28
33	·07933	27
34	·07962	26
35	·07991	25
36	·08020	24
37	·08049	23
38	·08078	22
39	·08107	21
40	·08136	20
41	·08165	19
42	·08194	18
43	·08223	17
44	·08252	16
45	·08281	15
46	·08310	14
47	·08339	13
48	·08368	12
49	·08397	11
50	·08426	10
51	·08455	9
52	·08484	8
53	·08513	7
54	·08542	6
55	·08571	5
56	·08600	4
57	·08629	3
58	·08658	2
59	·08687	1
60	·08716	0°85
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

4 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
4° 0'	0·698	1·395	2·093	2·790	3·488	4·185	4·883	5·580	6·278	6·976	60'
5	0·712	1·424	2·136	2·848	3·560	4·272	4·984	5·696	6·408	7·120	55
10	0·726	1·453	2·180	2·906	3·633	4·359	5·086	5·813	6·539	7·266	50
15	0·741	1·482	2·223	2·964	3·705	4·447	5·188	5·929	6·670	7·411	45
20	0·756	1·511	2·267	3·022	3·778	4·533	5·289	6·045	6·800	7·556	40
25	0·770	1·540	2·310	3·080	3·850	4·621	5·391	6·161	6·931	7·701	35
30	0·785	1·569	2·354	3·138	3·923	4·707	5·492	6·277	7·061	7·846	30
35	0·799	1·598	2·397	3·196	3·995	4·795	5·594	6·393	7·192	7·991	25
40	0·814	1·627	2·441	3·254	4·068	4·881	5·695	6·509	7·322	8·136	20
45	0·828	1·656	2·484	3·312	4·140	4·969	5·797	6·625	7·453	8·281	15
50	0·843	1·685	2·528	3·370	4·213	5·055	5·898	6·741	7·583	8·426	10
55	0·857	1·714	2·571	3·428	4·285	5·143	6·000	6·857	7·714	8·571	5
60	0·872	1·743	2·615	3·486	4·358	5·229	6·101	6·972	7·844	8·716	85° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

85 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
5° 0'	·99619	60'
1	·99617	59
2	·99614	58
3	·99612	57
4	·99609	56
5	·99607	55
6	·99604	54
7	.99601	53
8	·99599	52
9	·99596	51
10	·99594	50
11	·99591	49
12	·99588	48
13	·99586	47
14	·99583	46
15	·99580	45
16	·99578	44
17	·99575	43
18	·99572	42
19	·99570	41
20	·99567	40
21	·99564	39
22	·99562	38
23	·99559	37
24	·99556	36
25	·99553	35
26	·99551	34
27	·99548	33
28	·99545	32
29	·99542	31
30	·99540	30
31	·99537	29
32	·99534	28
33	·99531	27
34	·99528	26
35	·99525	25
36	·99523	24
37	·99520	23
38	·99517	22
39	·99514	21
40	·99511	20
41	·99508	19
42	·99505	18
43	·99503	17
44	·99500	16
45	·99497	15
46	·99494	14
47	·99491	13
48	·99488	12
49	·99485	11
50	·99482	10
51	·99479	9
52	·99476	8
53	·99473	7
54	·99470	6
55	·99467	5
56	·99464	4
57	·99461	3
58	·99458	2
59	·99455	1
60	·99452	0'84
	Sines	

Departures, or Difference of Levels

5 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
5° 0'	9·962	19·924	29·886	39·848	49·809	59·771	69·733	79·695	89·657	99·619	60'
5	9·961	19·921	29·882	39·842	49·803	59·764	69·725	79·685	89·646	99·607	55
10	9·959	19·919	29·878	39·838	49·797	59·756	69·716	79·675	89·635	99·594	50
15	9·958	19·916	29·874	39·832	49·790	59·748	69·706	79·664	89·622	99·580	45
20	9·957	19·913	29·870	39·827	49·783	59·740	69·697	79·654	89·610	99·567	40
25	9·955	19·911	29·866	39·821	49·776	59·732	69·687	79·642	89·600	99·553	35
30	9·954	19·908	29·862	39·816	49·769	59·723	69·677	79·631	89·585	99·539	30
35	9·952	19·905	29·857	39·810	49·762	59·715	69·667	79·620	89·572	99·525	25
40	9·951	19·902	29·853	39·804	49·755	59·706	69·658	79·609	89·560	99·511	20
45	9·950	19·899	29·849	39·799	49·748	59·698	69·648	79·598	89·547	99·497	15
50	9·948	19·896	29·845	39·793	49·741	59·689	69·637	79·586	89·534	99·482	10
55	9·947	19·893	29·840	39·787	49·733	59·680	69·627	79·574	89·520	99·467	5
60	9·945	19·890	29·836	39·781	49·726	59·671	69·616	79·561	89·507	99·452	84° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

84 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
5° 0'	·08716	60'
1	·08744	59
2	·08773	58
3	·08802	57
4	·08831	56
5	·08860	55
6	·08889	54
7	·08918	53
8	·08947	52
9	·08976	51
10	·09005	50
11	·09034	49
12	·09063	48
13	·09092	47
14	·09121	46
15	·09150	45
16	·09179	44
17	·09208	43
18	·09237	42
19	·09266	41
20	·09295	40
21	·09324	39
22	·09353	38
23	·09382	37
24	·09411	36
25	·09440	35
26	·09467	34
27	·09498	33
28	·09527	32
29	·09556	31
30	·09585	30
31	·09613	29
32	·09642	28
33	·09671	27
34	·09700	26
35	·09729	25
36	·09758	24
37	·09787	23
38	·09816	22
39	·09845	21
40	·09874	20
41	·09903	19
42	·09932	18
43	·09961	17
44	·09990	16
45	·10019	15
46	·10048	14
47	·10077	13
48	·10106	12
49	·10135	11
50	·10164	10
51	·10192	9
52	·10221	8
53	·10250	7
54	·10279	6
55	·10308	5
56	·10337	4
57	·10366	3
58	·10395	2
59	·10424	1
60	·10453	0·84
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

5 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
5° 0'	0·872	1·743	2·615	3·486	4·358	5·229	6·101	6·972	7·844	8·716	60'
5	0·886	1·772	2·658	3·544	4·430	5·316	6·202	7·088	7·974	8·860	55
10	0·900	1·801	2·702	3·602	4·503	5·403	6·304	7·204	8·105	9·005	50
15	0·915	1·830	2·745	3·660	4·575	5·490	6·405	7·320	8·235	9·150	45
20	0·929	1·859	2·788	3·718	4·647	5·577	6·506	7·436	8·365	9·295	40
25	0·944	1·888	2·832	3·776	4·720	5·664	6·608	7·552	8·496	9·440	35
30	0·958	1·917	2·875	3·834	4·792	5·751	6·709	7·668	8·626	9·585	30
35	0·973	1·946	2·919	3·892	4·865	5·838	6·810	7·783	8·756	9·729	25
40	0·987	1·975	2·962	3·950	4·937	5·924	6·912	7·899	8·887	9·874	20
45	1·002	2·004	3·006	4·007	5·009	6·011	7·013	8·015	9·017	10·919	15
50	1·016	2·033	3·049	4·065	5·082	6·098	7·114	8·131	9·147	10·163	10
55	1·031	2·062	3·092	4·123	5·154	6·185	7·216	8·246	9·277	10·308	5
60	1·045	2·090	3·136	4·181	5·226	6·272	7·317	8·363	9·408	10·453	84° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

84 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
6° 0′	·99452	60′
1	·99449	59
2	·99446	58
3	·99443	57
4	·99440	56
5	·99437	55
6	·99434	54
7	·99431	53
8	·99428	52
9	·99424	51
10	·99421	50
11	·99418	49
12	·99415	48
13	·99412	47
14	·99409	46
15	·99406	45
16	·99402	44
17	·99399	43
18	·99396	42
19	·99393	41
20	·99390	40
21	·99386	39
22	·99383	38
23	·99380	37
24	·99377	36
25	·99373	35
26	·99370	34
27	·99367	33
28	·99364	32
29	·99360	31
30	·99357	30
31	·99354	29
32	·99351	28
33	·99347	27
34	·99344	26
35	·99341	25
36	·99337	24
37	·99334	23
38	·99331	22
39	·99327	21
40	·99324	20
41	·99320	19
42	·99317	18
43	·99314	17
44	·99310	16
45	·99307	15
46	·99303	14
47	·99300	13
48	·99297	12
49	·99293	11
50	·99290	10
51	·99286	9
52	·99283	8
53	·99279	7
54	·99276	6
55	·99272	5
56	·99269	4
57	·99265	3
58	·99262	2
59	·99258	1
60	·99253	0°83
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

6 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
6° 0′	9·945	19·890	29·836	39·781	49·726	59·671	69·616	79·561	89·507	99·452	60′
5	9·944	19·887	29·831	39·775	49·718	59·662	69·606	79·550	89·493	99·437	55
10	9·942	19·884	29·826	39·768	49·710	59·652	69·595	79·537	89·479	99·421	50
15	9·941	19·881	29·822	39·762	49·703	59·644	69·584	79·525	89·465	99·406	45
20	9·939	19·878	29·817	39·756	49·695	59·634	69·573	79·512	89·451	99·390	40
25	9·937	19·874	29·812	39·749	49·686	59·624	69·561	79·498	89·436	99·373	35
30	9·936	19·871	29·807	39·743	49·678	59·614	69·550	79·486	89·421	99·357	30
35	9·934	19·868	29·802	39·736	49·670	59·605	69·539	79·473	89·407	99·341	25
40	9·932	19·865	29·797	39·730	49·662	59·594	69·527	79·459	89·391	99·324	20
45	9·931	19·861	29·792	39·723	49·653	59·584	69·515	79·445	89·376	99·307	15
50	9·929	19·858	29·787	39·716	49·645	59·574	69·503	79·432	89·361	99·290	10
55	9·927	19·854	29·782	39·709	49·636	59·563	69·490	79·418	89·345	99·272	5
60	9·925	19·851	29·776	39·702	49·627	59·553	69·478	79·404	89·329	99·255	83° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

83 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels	Sines	
6° 0′	·10453	60′
1	·10482	59
2	·10511	58
3	·10540	57
4	·10568	56
5	·10597	55
6	·10626	54
7	·10655	53
8	·10684	52
9	·10713	51
10	·10742	50
11	·10771	49
12	·10800	48
13	·10829	47
14	·10858	46
15	·10887	45
16	·10916	44
17	·10944	43
18	·10973	42
19	·11002	41
20	·11031	40
21	·11060	39
22	·11089	38
23	·11118	37
24	·11147	36
25	·11176	35
26	·11205	34
27	·11234	33
28	·11262	32
29	·11291	31
30	·11320	30
31	·11349	29
32	·11378	28
33	·11407	27
34	·11436	26
35	·11465	25
36	·11494	24
37	·11523	23
38	·11551	22
39	·11580	21
40	·11609	20
41	·11638	19
42	·11667	18
43	·11696	17
44	·11724	16
45	·11754	15
46	·11783	14
47	·11811	13
48	·11840	12
49	·11869	11
50	·11898	10
51	·11927	9
52	·11956	8
53	·11985	7
54	·12014	6
55	·12043	5
56	·12071	4
57	·12100	3
58	·12129	2
59	·12158	1
60	·12187	0 83°
	Cosines	
Latitudes, or Horizontal Distances for Difference of Levels		

DEPARTURES, OR DIFFERENCE OF LEVELS

6 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
6° 0′	1·045	2·090	3·136	4·181	5·226	6·272	7·317	8·363	9·408	10·453	60′
5	1·060	2·119	3·179	4·239	5·299	6·358	7·418	8·478	9·538	10·597	55
10	1·074	2·148	3·223	4·297	5·371	6·445	7·519	8·594	9·668	10·742	50
15	1·089	2·177	3·266	4·355	5·443	6·532	7·621	8·709	9·798	10·887	45
20	1·103	2·206	3·309	4·412	5·516	6·619	7·722	8·825	9·928	11·031	40
25	1·118	2·235	3·353	4·470	5·588	6·705	7·823	8·941	10·058	11·176	35
30	1·132	2·264	3·396	4·528	5·660	6·792	7·924	9·056	10·188	11·320	30
35	1·146	2·293	3·439	4·585	5·732	6·879	8·025	9·172	10·318	11·465	25
40	1·161	2·322	3·483	4·644	5·805	6·966	8·126	9·287	10·448	11·609	20
45	1·175	2·351	3·526	4·701	5·877	7·052	8·228	9·403	10·578	11·754	15
50	1·190	2·380	3·569	4·759	5·949	7·139	8·329	9·518	10·708	11·898	10
55	1·204	2·408	3·613	4·817	6·021	7·225	8·430	9·634	10·838	12·043	5
60	1·219	2·437	3·656	4·875	6·093	7·312	8·531	9·749	10·968	12·187	83° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

83 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
7° 0'	·99255	60'
1	·99251	59
2	·99247	58
3	·99244	57
4	·99240	56
5	·99237	55
6	·99233	54
7	·99229	53
8	·99226	52
9	·99222	51
10	·99219	50
11	·99215	49
12	·99211	48
13	·99208	47
14	·99204	46
15	·99200	45
16	·99197	44
17	·99193	43
18	·99189	42
19	·99186	41
20	·99182	40
21	·99178	39
22	·99175	38
23	·99171	37
24	·99167	36
25	·99163	35
26	·99160	34
27	·99156	33
28	·99152	32
29	·99148	31
30	·99144	30
31	·99141	29
32	·99137	28
33	·99133	27
34	·99129	26
35	·99125	25
36	·99122	24
37	·99118	23
38	·99114	22
39	·99110	21
40	·99106	20
41	·99102	19
42	·99098	18
43	·99094	17
44	·99090	16
45	·99086	15
46	·99083	14
47	·99079	13
48	·99075	12
49	·99071	11
50	·99067	10
51	·99063	9
52	·99059	8
53	·99055	7
54	·99051	6
55	·99047	5
56	·99043	4
57	·99039	3
58	·99035	2
59	·99031	1
60	·99027	0 ·82
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

7 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
7° 0'	9·925	19·851	29·776	39·702	49·627	59·553	69·478	79·404	89·329	99·255	60'
5	9·924	19·847	29·771	39·695	49·618	59·542	69·466	79·390	89·313	99·237	55
10	9·922	19·844	29·766	39·688	49·609	59·531	69·453	79·375	89·297	99·219	50
15	9·920	19·840	29·760	39·680	49·600	59·520	69·440	79·360	89·280	99·200	45
20	9·918	19·836	29·755	39·673	49·591	59·509	69·427	79·346	89·264	99·182	40
25	9·916	19·832	29·749	39·665	49·581	59·498	69·414	79·330	89·247	99·163	35
30	9·914	19·829	29·743	39·658	49·572	59·486	69·401	79·315	89·230	99·144	30
35	9·912	19·825	29·737	39·650	49·562	59·475	69·387	79·300	89·212	99·125	25
40	9·911	19·821	29·732	39·642	49·553	59·464	69·374	79·285	89·195	99·106	20
45	9·909	19·817	29·726	39·634	49·543	59·452	69·360	79·269	89·177	99·086	15
50	9·907	19·813	29·720	39·627	49·533	59·440	69·347	79·254	89·160	99·067	10
55	9·905	19·809	29·714	39·619	49·523	59·428	69·333	79·238	89·142	99·047	5
60	9·903	19·805	29·708	39·611	49·513	59·416	69·319	79·222	89·124	99·027	82° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

82 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
7° 0′	·12187	60′
1	·12216	59
2	·12245	58
3	·12274	57
4	·12302	56
5	·12331	55
6	·12360	54
7	·12389	53
8	·12418	52
9	·12447	51
10	·12476	50
11	·12504	49
12	·12533	48
13	·12562	47
14	·12591	46
15	·12620	45
16	·12649	44
17	·12678	43
18	·12706	42
19	·12735	41
20	·12764	40
21	·12793	39
22	·12822	38
23	·12851	37
24	·12880	36
25	·12908	35
26	·12937	34
27	·12966	33
28	·12995	32
29	·13024	31
30	·13053	30
31	·13081	29
32	·13110	28
33	·13139	27
34	·13168	26
35	·13197	25
36	·13226	24
37	·13254	23
38	·13283	22
39	·13312	21
40	·13341	20
41	·13370	19
42	·13398	18
43	·13427	17
44	·13456	16
45	·13485	15
46	·13514	14
47	·13543	13
48	·13571	12
49	·13600	11
50	·13629	10
51	·13658	9
52	·13687	8
53	·13716	7
54	·13744	6
55	·13773	5
56	·13802	4
57	·13831	3
58	·13860	2
59	·13888	1
60	·13917	0 ·82
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

7 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
7° 0′	1·219	2·437	3·656	4·875	6·093	7·312	8·531	9·749	10·968	12·187	60′
5	1·233	2·466	3·699	4·932	6·165	7·399	8·632	9·865	11·098	12·331	55
10	1·248	2·495	3·743	4·990	6·238	7·485	8·733	9·980	11·228	12·476	50
15	1·262	2·524	3·786	5·048	6·310	7·572	8·834	10·096	11·358	12·620	45
20	1·276	2·553	3·829	5·106	6·382	7·658	8·935	10·211	11·488	12·764	40
25	1·291	2·582	3·872	5·163	6·454	7·745	9·036	10·327	11·618	12·908	35
30	1·305	2·610	3·916	5·221	6·526	7·832	9·137	10·442	11·747	13·053	30
35	1·320	2·639	3·959	5·279	6·598	7·918	9·238	10·557	11·877	13·197	25
40	1·334	2·668	4·002	5·336	6·670	8·005	9·339	10·673	12·007	13·341	20
45	1·348	2·697	4·045	5·394	6·742	8·091	9·440	10·788	12·137	13·485	15
50	1·363	2·726	4·089	5·452	6·815	8·177	9·540	10·903	12·266	13·629	10
55	1·377	2·755	4·132	5·509	6·886	8·264	9·641	11·019	12·396	13·773	5
60	1·392	2·783	4·175	5·567	6·959	8·350	9·742	11·134	12·526	13·917	82° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

82 Deg. Latitudes, or Horizontal Distances for Difference of Levels

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

8° 0'	Cosines	60'
1	·99023	59
2	·99019	58
3	·99015	57
4	·99011	56
5	·99006	55
6	·99002	54
7	·98998	53
8	·98994	52
9	·98990	51
10	·98986	50
11	·98982	49
12	·98978	48
13	·98973	47
14	·98969	46
15	·98965	45
16	·98961	44
17	·98957	43
18	·98953	42
19	·98948	41
20	·98944	40
21	·98940	39
22	·98936	38
23	·98931	37
24	·98927	36
25	·98923	35
26	·98919	34
27	·98914	33
28	·98910	32
29	·98906	31
30	·98902	30
31	·98897	29
32	·98893	28
33	·98889	27
34	·98884	26
35	·98880	25
36	·98876	24
37	·98871	23
38	·98867	22
39	·98862	21
40	·98858	20
41	·98854	19
42	·98849	18
43	·98845	17
44	·98841	16
45	·98836	15
46	·98832	14
47	·98827	13
48	·98823	12
49	·98818	11
50	·98814	10
51	·98809	9
52	·98805	8
53	·98800	7
54	·98796	6
55	·98791	5
56	·98787	4
57	·98782	3
58	·98778	2
59	·98773	1
60	·98769	0·81
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

8 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
8° 0'	9·903	19·805	29·708	39·611	49·513	59·416	69·319	79·222	89·124	99·027	60'
5	9·901	19·801	29·702	39·602	49·503	59·404	69·304	79·205	89·105	99·006	55
10	9·898	19·797	29·696	39·594	49·493	59·392	69·290	79·189	89·087	98·986	50
15	9·896	19·793	29·689	39·586	49·482	59·379	69·275	79·172	89·068	98·965	45
20	9·894	19·789	29·683	39·578	49·472	59·366	69·261	79·155	89·050	98·944	40
25	9·892	19·785	29·677	39·569	49·461	59·354	69·246	79·138	89·031	98·923	35
30	9·890	19·780	29·670	39·560	49·450	59·340	69·231	79·121	89·011	98·901	30
35	9·888	19·776	29·664	39·552	49·440	59·328	69·216	79·104	88·992	98·880	25
40	9·886	19·772	29·657	39·543	49·429	59·315	69·201	79·086	88·972	98·858	20
45	9·884	19·767	29·651	39·534	49·418	59·302	69·185	79·068	88·952	98·836	15
50	9·881	19·763	29·644	39·526	49·407	59·288	69·170	79·051	88·933	98·814	10
55	9·879	19·758	29·637	39·516	49·395	59·275	69·154	79·033	88·912	98·791	5
60	9·877	19·754	29·631	39·508	49·384	59·261	69·138	79·015	88·892	98·769	81° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

81 Deg. Departures, or Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

Departures, or Difference of Levels

	Sines	
8° 0'	·13917	60'
1	·13946	59
2	·13975	58
3	·14004	57
4	·14032	56
5	·14061	55
6	·14090	54
7	·14119	53
8	·14147	52
9	·14176	51
10	·14205	50
11	·14234	49
12	·14263	48
13	·14292	47
14	·14320	46
15	·14349	45
16	·14378	44
17	·14407	43
18	·14436	42
19	·14464	41
20	·14493	40
21	·14522	39
22	·14551	38
23	·14579	37
24	·14608	36
25	·14637	35
26	·14666	34
27	·14694	33
28	·14723	32
29	·14752	31
30	·14781	30
31	·14810	29
32	·14838	28
33	·14867	27
34	·14896	26
35	·14925	25
36	·14953	24
37	·14982	23
38	·15011	22
39	·15040	21
40	·15069	20
41	·15097	19
42	·15126	18
43	·15155	17
44	·15184	16
45	·15212	15
46	·15241	14
47	·15270	13
48	·15298	12
49	·15327	11
50	·15356	10
51	·15385	9
52	·15414	8
53	·15442	7
54	·15471	6
55	·15500	5
56	·15528	4
57	·15557	3
58	·15586	2
59	·15615	1
60	·15643	0·81
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

8 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
8° 0'	1·392	2·783	4·175	5·567	6·959	8·350	9·742	11·134	12·526	13·917	60'
5	1·406	2·812	4·218	5·624	7·031	8·437	9·843	11·249	12·655	14·061	55
10	1·420	2·841	4·262	5·682	7·103	8·523	9·944	11·364	12·785	14·205	50
15	1·435	2·870	4·305	5·740	7·175	8·610	10·044	11·479	12·914	14·349	45
20	1·449	2·899	4·348	5·797	7·247	8·696	10·145	11·594	13·044	14·493	40
25	1·464	2·927	4·391	5·855	7·318	8·782	10·246	11·710	13·173	14·637	35
30	1·478	2·956	4·434	5·912	7·390	8·868	10·347	11·825	13·303	14·781	30
35	1·492	2·985	4·477	5·970	7·462	8·955	10·447	11·940	13·432	14·925	25
40	1·507	3·014	4·521	6·027	7·534	9·041	10·548	12·055	13·562	15·069	20
45	1·521	3·042	4·564	6·085	7·606	9·127	10·649	12·170	13·691	15·212	15
50	1·536	3·071	4·607	6·142	7·678	9·214	10·749	12·285	13·820	15·356	10
55	1·550	3·100	4·650	6·200	7·750	9·300	10·850	12·400	13·950	15·500	5
60	1·564	3·129	4·693	6·257	7·822	9·386	10·950	12·515	14·079	15·643	81° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

81 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
9° 0'	·98769	60'
1	·98764	59
2	·98760	58
3	·98755	57
4	·98751	56
5	·98746	55
6	·98741	54
7	·98737	53
8	·98732	52
9	·98727	51
10	·98723	50
11	·98718	49
12	·98714	48
13	·98709	47
14	·98704	46
15	·98700	45
16	·98695	44
17	·98690	43
18	·98686	42
19	·98681	41
20	·98676	40
21	·98671	39
22	·98667	38
23	·98662	37
24	·98657	36
25	·98652	35
26	·98648	34
27	·98643	33
28	·98638	32
29	·98633	31
30	·98629	30
31	·98624	29
32	·98619	28
33	·98614	27
34	·98609	26
35	·98604	25
36	·98600	24
37	·98595	23
38	·98590	22
39	·98585	21
40	·98580	20
41	·98575	19
42	·98570	18
43	·98565	17
44	·98560	16
45	·98556	15
46	·98551	14
47	·98546	13
48	·98541	12
49	·98536	11
50	·98531	10
51	·98526	9
52	·98521	8
53	·98516	7
54	·98511	6
55	·98506	5
56	·98501	4
57	·98496	3
58	·98491	2
59	·98486	1
60	·98481	0·80
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

9 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
9° 0'	9·877	19·754	29·631	39·508	49·384	59·261	69·138	79·015	88·892	98·769	60'
5	9·875	19·749	29·624	39·498	49·373	59·248	69·122	78·997	88·871	98·746	55
10	9·872	19·745	29·617	39·489	49·361	59·234	69·106	78·978	88·850	98·723	50
15	9·870	19·740	29·610	39·480	49·350	59·220	69·090	78·960	88·830	98·700	45
20	9·868	19·735	29·603	39·470	49·338	59·206	69·073	78·941	88·808	98·676	40
25	9·865	19·730	29·596	39·461	49·326	59·191	69·056	78·922	88·787	98·652	35
30	9·863	19·726	29·588	39·451	49·314	59·177	69·040	78·902	88·765	98·628	30
35	9·860	19·721	29·581	39·441	49·302	59·162	69·023	78·883	88·744	98·604	25
40	9·858	19·716	29·574	39·432	49·290	59·148	69·006	78·864	88·722	98·580	20
45	9·856	19·711	29·567	39·422	49·278	59·133	68·989	78·845	88·700	98·556	15
50	9·853	19·706	29·559	39·412	49·265	59·119	68·972	78·825	88·678	98·531	10
55	9·851	19·701	29·552	39·402	49·253	59·104	68·954	78·805	88·655	98·506	5
60	9·848	19·696	29·544	39·392	49·240	59·089	68·937	78·785	88·633	98·481	80° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

80 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

9°	Sines	
0'	·15643	60'
1	·15672	59
2	·15701	58
3	·15730	57
4	·15758	56
5	·15787	55
6	·15816	54
7	·15844	53
8	·15873	52
9	·15902	51
10	·15931	50
11	·15959	49
12	·15988	48
13	·16017	47
14	·16045	46
15	·16074	45
16	·16103	44
17	·16132	43
18	·16160	42
19	·16189	41
20	·16218	40
21	·16246	39
22	·16275	38
23	·16304	37
24	·16333	36
25	·16361	35
26	·16390	34
27	·16419	33
28	·16447	32
29	·16476	31
30	·16505	30
31	·16533	29
32	·16562	28
33	·16591	27
34	·16619	26
35	·16648	25
36	·16677	24
37	·16706	23
38	·16734	22
39	·16763	21
40	·16792	20
41	·16820	19
42	·16849	18
43	·16878	17
44	·16906	16
45	·16935	15
46	·16964	14
47	·16992	13
48	·17021	12
49	·17050	11
50	·17078	10
51	·17107	9
52	·17136	8
53	·17164	7
54	·17193	6
55	·17222	5
56	·17250	4
57	·17279	3
58	·17307	2
59	·17336	1
60	·17365	0 80°
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

9 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
9° 0'	1·564	3·129	4·693	6·257	7·822	9·386	10·950	12·515	14·079	15·643	60'
5	1·579	3·157	4·736	6·315	7·893	9·472	11·051	12·630	14·208	15·787	55
10	1·593	3·186	4·779	6·372	7·965	9·558	11·151	12·744	14·338	15·931	50
15	1·607	3·215	4·822	6·430	8·037	9·644	11·252	12·859	14·467	16·074	45
20	1·622	3·243	4·865	6·487	8·109	9·731	11·352	12·974	14·596	16·218	40
25	1·636	3·272	4·908	6·544	8·180	9·817	11·453	13·089	14·725	16·361	35
30	1·650	3·301	4·951	6·602	8·252	9·903	11·553	13·204	14·854	16·505	30
35	1·665	3·330	4·994	6·659	8·324	9·989	11·654	13·318	14·983	16·648	25
40	1·679	3·358	5·037	6·717	8·396	10·075	11·754	13·433	15·112	16·792	20
45	1·694	3·387	5·080	6·774	8·467	10·161	11·854	13·548	15·241	16·935	15
50	1·708	3·416	5·123	6·831	8·539	10·247	11·955	13·663	15·370	17·078	10
55	1·722	3·444	5·166	6·887	8·611	10·333	12·055	13·777	15·499	17·221	5
60	1·736	3·473	5·209	6·946	8·682	10·419	12·155	13·892	15·628	17·365	0 80°
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

80 Deg. Latitudes, or Horizontal Distances for Difference of Levels

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
10° 0′	·98481	60′
1	·98476	59
2	·98471	58
3	·98466	57
4	·98461	56
5	·98455	55
6	·98450	54
7	·98445	53
8	·98440	52
9	·98435	51
10	·98430	50
11	·98425	49
12	·98420	48
13	·98414	47
14	·98409	46
15	·98404	45
16	·98399	44
17	·98394	43
18	·98388	42
19	·98383	41
20	·98378	40
21	·98373	39
22	·98368	38
23	·98362	37
24	·98357	36
25	·98352	35
26	·98347	34
27	·98341	33
28	·98336	32
29	·98331	31
30	·98325	30
31	·98320	29
32	·98315	28
33	·98310	27
34	·98304	26
35	·98299	25
36	·98293	24
37	·98288	23
38	·98283	22
39	·98277	21
40	·98272	20
41	·98267	19
42	·98261	18
43	·98256	17
44	·98250	16
45	·98245	15
46	·98240	14
47	·98234	13
48	·98229	12
49	·98223	11
50	·98218	10
51	·98212	9
52	·98207	8
53	·98201	7
54	·98196	6
55	·98190	5
56	·98185	4
57	·98179	3
58	·98174	2
59	·98168	1
60	·98163	0 79°
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

10 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
10° 0′	9·848	19·696	29·544	39·392	49·240	59·089	68·937	78·785	88·633	98·481	60′
5	9·845	19·691	29·536	39·382	49·227	59·073	68·918	78·764	88·609	98·455	55
10	9·843	19·686	29·529	39·372	49·215	59·058	68·901	78·744	88·587	98·430	50
15	9·840	19·681	29·521	39·362	49·202	59·042	68·883	78·723	88·564	98·404	45
20	9·838	19·676	29·513	39·351	49·189	59·027	68·865	78·702	88·540	98·378	40
25	9·835	19·670	29·506	39·341	49·176	59·011	68·846	78·681	88·517	98·352	35
30	9·832	19·665	29·497	39·330	49·162	58·995	68·827	78·660	88·492	98·325	30
35	9·830	19·660	29·490	39·320	49·149	58·979	68·809	78·639	88·469	98·299	25
40	9·827	19·654	29·482	39·309	49·136	58·963	68·790	78·618	88·445	98·272	20
45	9·824	19·649	29·473	39·298	49·122	58·947	68·771	78·596	88·420	98·245	15
50	9·822	19·644	29·465	39·287	49·109	58·931	68·753	78·574	88·396	98·218	10
55	9·819	19·638	29·457	39·276	49·095	58·914	68·733	78·552	88·371	98·190	5
60	9·816	19·633	29·449	39·265	49·081	58·898	68·714	78·530	88·347	98·163	79° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

79 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
10° 0'	·17365	60'
1	·17393	59
2	·17422	58
3	·17451	57
4	·17479	56
5	·17508	55
6	·17537	54
7	·17565	53
8	·17594	52
9	·17623	51
10	·17651	50
11	·17680	49
12	·17708	48
13	·17737	47
14	·17766	46
15	·17794	45
16	·17823	44
17	·17852	43
18	·17880	42
19	·17909	41
20	·17937	40
21	·17966	39
22	·17995	38
23	·18023	37
24	·18052	36
25	·18080	35
26	·18109	34
27	·18138	33
28	·18166	32
29	·18195	31
30	·18224	30
31	·18252	29
32	·18281	28
33	·18309	27
34	·18338	26
35	·18366	25
36	·18395	24
37	·18424	23
38	·18452	22
39	·18481	21
40	·18509	20
41	·18538	19
42	·18567	18
43	·18595	17
44	·18624	16
45	·18652	15
46	·18681	14
47	·18710	13
48	·18738	12
49	·18767	11
50	·18795	10
51	·18823	9
52	·18852	8
53	·18881	7
54	·18909	6
55	·18938	5
56	·18967	4
57	·18995	3
58	·19024	2
59	·19052	1
60	·19081	0° 79
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

10 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
10° 0'	1·736	3·473	5·209	6·946	8·682	10·419	12·155	13·892	15·628	17·365	60'
5	1·751	3·502	5·252	7·003	8·754	10·505	12·256	14·006	15·757	17·508	55
10	1·765	3·530	5·295	7·060	8·826	10·591	12·356	14·121	15·886	17·651	50
15	1·779	3·559	5·338	7·118	8·897	10·677	12·456	14·235	16·015	17·794	45
20	1·794	3·587	5·381	7·175	8·969	10·762	12·556	14·350	16·144	17·937	40
25	1·808	3·616	5·424	7·232	9·040	10·848	12·656	14·464	16·272	18·080	35
30	1·822	3·645	5·467	7·289	9·112	10·934	12·756	14·579	16·401	18·223	30
35	1·837	3·673	5·510	7·347	9·183	11·020	12·857	14·693	16·530	18·366	25
40	1·851	3·702	5·553	7·404	9·255	11·106	12·957	14·808	16·658	18·509	20
45	1·865	3·730	5·596	7·461	9·326	11·191	13·057	14·922	16·787	18·652	15
50	1·879	3·759	5·638	7·518	9·398	11·277	13·157	15·036	16·916	18·795	10
55	1·894	3·788	5·681	7·575	9·469	11·363	13·257	15·150	17·044	18·938	5
60	1·908	3·816	5·724	7·632	9·540	11·448	13·357	15·265	17·173	19·081	79° 0
	10	20	30	40	50	60	70	80	90	100	

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

79 Deg. Latitudes, or Horizontal Distances for Difference of Levels

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
11° 0′	·98163	60′
1	·98157	59
2	·98152	58
3	·98146	57
4	·98140	56
5	·98135	55
6	·98129	54
7	·98124	53
8	·98118	52
9	·98112	51
10	·98107	50
11	·98101	49
12	·98095	48
13	·98090	47
14	·98084	46
15	·98078	45
16	·98072	44
17	·98067	43
18	·98061	42
19	·98056	41
20	·98050	40
21	·98044	39
22	·98039	38
23	·98033	37
24	·98027	36
25	·98021	35
26	·98016	34
27	·98009	33
28	·98004	32
29	·97998	31
30	·97992	30
31	·97987	29
32	·97981	28
33	·97975	27
34	·97969	26
35	·97963	25
36	·97957	24
37	·97952	23
38	·97946	22
39	·97940	21
40	·97934	20
41	·97928	19
42	·97922	18
43	·97916	17
44	·97910	16
45	·97904	15
46	·97899	14
47	·97893	13
48	·97887	12
49	·97881	11
50	·97875	10
51	·97869	9
52	·97863	8
53	·97857	7
54	·97851	6
55	·97845	5
56	·97839	4
57	·97833	3
58	·97827	2
59	·97821	1
60	·97815	0 78
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

11 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
11° 0′	9·816	19·633	29·449	39·265	49·081	58·898	68·714	78·530	88·347	98·163	60′
5	9·813	19·627	29·440	39·254	49·067	58·881	68·694	78·508	88·321	98·135	55
10	9·811	19·621	29·432	39·243	49·053	58·864	68·675	78·486	88·296	98·107	50
15	9·808	19·616	29·423	39·231	49·039	58·847	68·655	78·462	88·270	98·078	45
20	9·805	19·610	29·415	39·220	49·025	58·830	68·635	78·440	88·245	98·050	40
25	9·802	19·604	29·406	39·208	49·010	58·813	68·615	78·417	88·219	98·021	35
30	9·799	19·598	29·398	39·197	48·996	58·795	68·594	78·394	88·193	97·992	30
35	9·796	19·593	29·389	39·185	48·981	58·778	68·574	78·370	88·167	97·963	25
40	9·793	19·587	29·380	39·174	48·967	58·760	68·554	78·347	88·140	97·934	20
45	9·790	19·581	29·371	39·161	48·952	58·742	68·533	78·323	88·114	97·904	15
50	9·787	19·575	29·362	39·150	48·937	58·725	68·512	78·300	88·087	97·875	10
55	9·784	19·569	29·353	39·138	48·922	58·707	68·491	78·276	88·060	97·845	5
60	9·781	19·563	29·344	39·126	48·907	58·689	68·470	78·252	88·033	97·815	78° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

78 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
11° 0′	·19081	60′
1	·19109	59
2	·19138	58
3	·19166	57
4	·19195	56
5	·19224	55
6	·19252	54
7	·19281	53
8	·19309	52
9	·19338	51
10	·19366	50
11	·19395	49
12	·19423	48
13	·19452	47
14	·19480	46
15	·19509	45
16	·19538	44
17	·19566	43
18	·19595	42
19	·19623	41
20	·19652	40
21	·19680	39
22	·19709	38
23	·19737	37
24	·19766	36
25	·19794	35
26	·19823	34
27	·19851	33
28	·19880	32
29	·19908	31
30	·19937	30
31	·19965	29
32	·19994	28
33	·20022	27
34	·20051	26
35	·20079	25
36	·20108	24
37	·20136	23
38	·20165	22
39	·20193	21
40	·20222	20
41	·20250	19
42	·20279	18
43	·20307	17
44	·20336	16
45	·20364	15
46	·20393	14
47	·20421	13
48	·20450	12
49	·20478	11
50	·20506	10
51	·20535	9
52	·20563	8
53	·20592	7
54	·20620	6
55	·20649	5
56	·20677	4
57	·20706	3
58	·20734	2
59	·20763	1
60	·20791	0 78°
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

11 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
11° 0′	1·908	3·816	5·724	7·632	9·540	11·448	13·357	15·265	17·173	19·081	60′
5	1·922	3·845	5·767	7·689	9·612	11·534	13·456	15·379	17·301	19·224	55
10	1·937	3·873	5·810	7·746	9·683	11·620	13·556	15·493	17·430	19·366	50
15	1·951	3·902	5·853	7·804	9·754	11·705	13·656	15·607	17·558	19·509	45
20	1·965	3·930	5·895	7·860	9·826	11·791	13·756	15·721	17·686	19·652	40
25	1·979	3·959	5·938	7·918	9·897	11·876	13·856	15·835	17·815	19·794	35
30	1·994	3·987	5·981	7·975	9·968	11·962	13·956	15·949	17·943	19·937	30
35	2·008	4·016	6·024	8·032	10·040	12·048	14·055	16·063	18·071	20·079	25
40	2·022	4·044	6·066	8·089	10·111	12·133	14·155	16·177	18·200	20·222	20
45	2·036	4·073	6·109	8·146	10·182	12·218	14·255	16·291	18·328	20·364	15
50	2·051	4·101	6·152	8·203	10·253	12·304	14·355	16·405	18·456	20·506	10
55	2·065	4·130	6·195	8·259	10·324	12·389	14·454	16·519	18·584	20·649	5
60	2·079	4·158	6·237	8·316	10·395	12·475	14·554	16·633	18·712	20·791	78° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

78 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
12° 0′	·97815	60′
1	·97809	59
2	·97803	58
3	·97797	57
4	·97790	56
5	·97784	55
6	·97778	54
7	·97772	53
8	·97766	52
9	·97760	51
10	·97754	50
11	·97748	49
12	·97742	48
13	·97735	47
14	·97729	46
15	·97723	45
16	·97717	44
17	·97711	43
18	·97705	42
19	·97698	41
20	·97692	40
21	·97686	39
22	·97680	38
23	·97673	37
24	·97667	36
25	·97661	35
26	·97655	34
27	·97648	33
28	·97642	32
29	·97636	31
30	·97630	30
31	·97623	29
32	·97617	28
33	·97611	27
34	·97604	26
35	·97598	25
36	·97592	24
37	·97585	23
38	·97579	22
39	·97573	21
40	·97566	20
41	·97560	19
42	·97553	18
43	·97547	17
44	·97541	16
45	·97534	15
46	·97528	14
47	·97521	13
48	·97515	12
49	·97508	11
50	·97502	10
51	·97496	9
52	·97489	8
53	·97483	7
54	·97476	6
55	·97470	5
56	·97463	4
57	·97457	3
58	·97450	2
59	·97444	1
60	·97437	0 ·77
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

12 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
12° 0′	9·781	19·563	29·344	39·126	48·907	58·689	68·470	78·252	88·033	97·815	60′
5	9·778	19·557	29·335	39·114	48·892	58·670	68·449	78·227	88·005	97·784	55
10	9·775	19·551	29·326	39·102	48·877	58·652	68·428	78·203	87·979	97·754	50
15	9·772	19·545	29·317	39·089	48·861	58·634	68·406	78·178	87·951	97·723	45
20	9·769	19·538	29·308	39·077	48·846	58·615	68·384	78·154	87·923	97·692	40
25	9·766	19·532	29·298	39·064	48·830	58·597	68·363	78·129	87·895	97·661	35
30	9·763	19·526	29·289	39·052	48·815	58·578	68·341	78·104	87·867	97·630	30
35	9·760	19·519	29·279	39·039	48·799	58·559	68·319	78·078	87·838	97·598	25
40	9·757	19·513	29·270	39·026	48·783	58·539	68·296	78·053	87·809	97·556	20
45	9·753	19·507	29·260	39·014	48·767	58·520	68·274	78·027	87·781	97·534	15
50	9·750	19·500	29·251	39·001	48·751	58·501	68·251	78·002	87·752	97·502	10
55	9·747	19·494	29·241	38·988	48·735	58·487	68·229	77·976	87·723	97·470	5
60	9·744	19·487	29·231	38·975	48·718	58·462	68·206	77·950	87·693	97·437	77 0
	10	20	30	40	50	60	70	80	90	100	

DEPARTURES, OR DIFFERENCE OF LEVELS

77 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
12° 0′	·20791	60′
1	·20820	59
2	·20848	58
3	·20876	57
4	·20905	56
5	·20933	55
6	·20962	54
7	·20990	53
8	·21019	52
9	·21047	51
10	·21076	50
11	·21104	49
12	·21132	48
13	·21161	47
14	·21189	46
15	·21218	45
16	·21246	44
17	·21275	43
18	·21303	42
19	·21331	41
20	·21360	40
21	·21388	39
22	·21417	38
23	·21445	37
24	·21473	36
25	·21502	35
26	·21530	34
27	·21559	33
28	·21587	32
29	·21616	31
30	·21644	30
31	·21672	29
32	·21701	28
33	·21729	27
34	·21757	26
35	·21786	25
36	·21814	24
37	·21843	23
38	·21871	22
39	·21899	21
40	·21928	20
41	·21956	19
42	·21985	18
43	·22013	17
44	·22041	16
45	·22070	15
46	·22098	14
47	·22126	13
48	·22155	12
49	·22183	11
50	·22212	10
51	·22240	9
52	·22268	8
53	·22297	7
54	·22325	6
55	·22353	5
56	·22382	4
57	·22410	3
58	·22438	2
59	·22467	1
60	·22495	0 77
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

12 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
12° 0′	2·079	4·158	6·237	8·316	10·395	12·475	14·554	16·633	18·712	20·791	60′
5	2·093	4·187	6·280	8·373	10·467	12·560	14·653	16·747	18·840	20·933	55
10	2·108	4·215	6·323	8·430	10·538	12·645	14·753	16·860	18·968	21·076	50
15	2·122	4·243	6·365	8·487	10·609	12·731	14·852	16·974	19·096	21·218	45
20	2·136	4·272	6·408	8·544	10·680	12·816	14·952	17·088	19·224	21·360	40
25	2·150	4·300	6·450	8·601	10·751	12·901	15·051	17·201	19·352	21·502	35
30	2·164	4·329	6·493	8·658	10·822	12·986	15·151	17·315	19·479	21·644	30
35	2·179	4·357	6·536	8·714	10·893	13·071	15·250	17·429	19·607	21·786	25
40	2·193	4·386	6·578	8·771	10·964	13·157	15·349	17·542	19·735	21·928	20
45	2·207	4·414	6·621	8·828	11·035	13·242	15·449	17·656	19·863	22·070	15
50	2·221	4·442	6·663	8·885	11·106	13·327	15·548	17·769	19·990	22·212	10
55	2·235	4·471	6·706	8·941	11·177	13·412	15·647	17·883	20·118	22·353	5
60	2·249	4·499	6·748	8·998	11·247	13·497	15·746	17·996	20·245	22·495	77° 0
	10	20	30	40	50	60	70	80	90	100	

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

77 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
13° 0'	·97437	60'
1	·97430	59
2	·97424	58
3	·97417	57
4	·97411	56
5	·97404	55
6	·97398	54
7	·97391	53
8	·97384	52
9	·97378	51
10	·97371	50
11	·97364	49
12	·97358	48
13	·97351	47
14	·97345	46
15	·97338	45
16	·97331	44
17	·97325	43
18	·97318	42
19	·97311	41
20	·97304	40
21	·97298	39
22	·97291	38
23	·97284	37
24	·97278	36
25	·97271	35
26	·97264	34
27	·97257	33
28	·97251	32
29	·97244	31
30	·97237	30
31	·97230	29
32	·97223	28
33	·97217	27
34	·97210	26
35	·97203	25
36	·97196	24
37	·97189	23
38	·97182	22
39	·97175	21
40	·97169	20
41	·97162	19
42	·97155	18
43	·97148	17
44	·97141	16
45	·97134	15
46	·97127	14
47	·97120	13
48	·97113	12
49	·97106	11
50	·97099	10
51	·97092	9
52	·97086	8
53	·97079	7
54	·97072	6
55	·97065	5
56	·97058	4
57	·97051	3
58	·97044	2
59	·97037	1
60	·97030	0° 76
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

13 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
13° 0'	9·744	19·487	29·231	38·975	48·718	58·462	68·206	77·950	87·693	97·437	60'
5	9·740	19·481	29·221	38·961	48·702	58·442	68·183	77·923	87·664	97·404	55
10	9·737	19·474	29·211	38·948	48·685	58·423	68·160	77·897	87·634	97·371	50
15	9·734	19·468	29·201	38·935	48·669	58·403	68·137	77·870	87·604	97·338	45
20	9·730	19·461	29·191	38·921	48·652	58·382	68·113	77·843	87·574	97·304	40
25	9·727	19·454	29·181	38·908	48·635	58·362	68·090	77·817	87·544	97·271	35
30	9·724	19·447	29·171	38·895	48·618	58·342	68·066	77·790	87·513	97·237	30
35	9·720	19·441	29·161	38·881	48·601	58·322	68·042	77·762	87·483	97·203	25
40	9·717	19·434	29·151	38·868	48·584	58·301	68·018	77·735	87·452	97·169	20
45	9·713	19·427	29·140	38·854	48·567	58·280	67·994	77·707	87·421	97·134	15
50	9·710	19·420	29·130	38·840	48·549	58·259	67·969	77·679	87·389	97·099	10
55	9·706	19·413	29·119	38·826	48·532	58·239	67·945	77·652	87·358	97·065	5
60	9·703	19·406	29·109	38·812	48·514	58·217	67·920	77·623	87·326	97·029	76° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

76 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
13° 0′	·22495	60′
1	·22523	59
2	·22552	58
3	·22580	57
4	·22608	56
5	·22637	55
6	·22665	54
7	·22693	53
8	·22722	52
9	·22750	51
10	·22778	50
11	·22807	49
12	·22835	48
13	·22863	47
14	·22892	46
15	·22920	45
16	·22948	44
17	·22977	43
18	·23005	42
19	·23033	41
20	·23062	40
21	·23090	39
22	·23118	38
23	·23146	37
24	·23175	36
25	·23203	35
26	·23231	34
27	·23260	33
28	·23289	32
29	·23316	31
30	·23344	30
31	·23373	29
32	·23401	28
33	·23429	27
34	·23458	26
35	·23486	25
36	·23514	24
37	·23542	23
38	·23571	22
39	·23599	21
40	·23627	20
41	·23655	19
42	·23684	18
43	·23712	17
44	·23740	16
45	·23769	15
46	·23797	14
47	·23825	13
48	·23853	12
49	·23882	11
50	·23910	10
51	·23938	9
52	·23966	8
53	·23995	7
54	·24023	6
55	·24051	5
56	·24079	4
57	·24107	3
58	·24136	2
59	·24164	1
60	·24192	0 76
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

13 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
13° 0′	2·249	4·499	6·748	8·998	11·247	13·497	15·746	17·996	20·245	22·495	60′
5	2·264	4·527	6·791	9·055	11·318	13·582	15·846	18·110	20·373	22·637	55
10	2·278	4·556	6·833	9·111	11·389	13·667	15·945	18·222	20·500	22·778	50
15	2·292	4·584	6·876	9·168	11·460	13·752	16·044	18·336	20·628	22·920	45
20	2·306	4·612	6·919	9·225	11·531	13·837	16·143	18·450	20·756	23·062	40
25	2·320	4·641	6·961	9·281	11·601	13·922	16·242	18·562	20·883	23·203	35
30	2·334	4·669	7·003	9·338	11·672	14·006	16·341	18·675	21·010	23·344	30
35	2·349	4·697	7·046	9·394	11·743	14·092	16·440	18·789	21·137	23·486	25
40	2·363	4·725	7·088	9·451	11·814	14·176	16·539	18·902	21·265	23·627	20
45	2·377	4·754	7·131	9·507	11·884	14·261	16·638	19·015	21·392	23·769	15
50	2·391	4·782	7·173	9·564	11·955	14·346	16·737	19·128	21·519	23·910	10
55	2·405	4·810	7·215	9·620	12·025	14·430	16·836	19·241	21·646	24·051	5
60	2·419	4·838	7·258	9·677	12·096	14·515	16·934	19·354	21·773	24·192	76° 0
	10	20	30	40	50	60	70	80	90	100	

76 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
14° 0′	·97030	60′
1	·97022	59
2	·97015	58
3	·97008	57
4	·97001	56
5	·96994	55
6	·96987	54
7	·96980	53
8	·96973	52
9	·96966	51
10	·96959	50
11	·96952	49
12	·96944	48
13	·96937	47
14	·96930	46
15	·96923	45
16	·96916	44
17	·96909	43
18	·96902	42
19	·96894	41
20	·96887	40
21	·96880	39
22	·96873	38
23	·96866	37
24	·97858	36
25	·96851	35
26	·96844	34
27	·96837	33
28	·96829	32
29	·96822	31
30	·96815	30
31	·96807	29
32	·96800	28
33	·96793	27
34	·96786	26
35	·96778	25
36	·96771	24
37	·96764	23
38	·96756	22
39	·96749	21
40	·96741	20
41	·96734	19
42	·96727	18
43	·96719	17
44	·96712	16
45	·96705	15
46	·96697	14
47	·96690	13
48	·96682	12
49	·96675	11
50	·96667	10
51	·96660	9
52	·96653	8
53	·96645	7
54	·96638	6
55	·96630	5
56	·96623	4
57	·96615	3
58	·96608	2
59	·96600	1
60	·96593	0 75°
	Sines	

Departures, or Difference of Levels

14 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
14° 0′	9·703	19·406	29·109	38·812	48·514	58·217	67·920	77·623	87·326	97·029	60′
5	9·699	19·399	29·098	38·797	48·497	58·196	67·896	77·595	87·295	96·994	55
10	9·696	19·392	29·088	38·784	48·479	58·175	67·871	77·567	87·263	96·959	50
15	9·692	19·385	29·077	38·769	48·461	58·154	67·846	77·538	87·231	96·923	45
20	9·689	19·377	29·066	38·755	48·443	58·132	67·821	77·510	87·198	96·887	40
25	9·685	19·370	29·055	38·740	48·425	58·111	67·796	77·481	87·166	96·851	35
30	9·681	19·363	29·044	38·726	48·407	58·089	67·770	77·452	87·133	96·815	30
35	9·678	19·356	29·033	38·711	48·389	58·067	67·745	77·422	87·100	96·778	25
40	9·674	19·348	29·022	38·696	48·370	58·045	67·719	77·393	87·067	96·741	20
45	9·670	19·341	29·011	38·682	48·352	58·022	67·693	77·363	87·034	96·704	15
50	9·667	19·333	29·000	38·667	48·333	58·000	67·667	77·334	87·000	96·667	10
55	9·663	19·326	28·989	38·652	48·315	57·978	67·641	77·304	86·967	96·630	5
60	9·659	19·318	28·978	38·637	48·296	57·955	67·614	77·274	86·933	96·592	75° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

75 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
14° 0′	·24192	60′
1	·24220	59
2	·24248	58
3	·24277	57
4	·24305	56
5	·24333	55
6	·24361	54
7	·24390	53
8	·24417	52
9	·24446	51
10	·24474	50
11	·24502	49
12	·24531	48
13	·24560	47
14	·24587	46
15	·24615	45
16	·24643	44
17	·24672	43
18	·24700	42
19	·24728	41
20	·24756	40
21	·24784	39
22	·24813	38
23	·24841	37
24	·24869	36
25	·24897	35
26	·24925	34
27	·24953	33
28	·24982	32
29	·25010	31
30	·25038	30
31	·25066	29
32	·25094	28
33	·25122	27
34	·25151	26
35	·25179	25
36	·25207	24
37	·25235	23
38	·25263	22
39	·25291	21
40	·25319	20
41	·25348	19
42	·25376	18
43	·25404	17
44	·25432	16
45	·25460	15
46	·25488	14
47	·25516	13
48	·25545	12
49	·25573	11
50	·25601	10
51	·25629	9
52	·25657	8
53	·25685	7
54	·25713	6
55	·25741	5
56	·25769	4
57	·25798	3
58	·25826	2
59	·25854	1
60	·25882	0 75
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

14 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
14° 0′	2·419	4·838	7·258	9·677	12·096	14·515	16·934	19·354	21·773	24·192	60′
5	2·433	4·867	7·300	9·733	12·166	14·600	17·033	19·467	21·900	24·333	55
10	2·447	4·895	7·342	9·790	12·237	14·685	17·132	19·579	22·027	24·474	50
15	2·461	4·923	7·385	9·846	12·308	14·769	17·231	19·692	22·154	24·615	45
20	2·476	4·951	7·427	9·902	12·378	14·854	17·329	19·805	22·281	24·756	40
25	2·490	4·979	7·469	9·959	12·448	14·938	17·428	19·918	22·407	24·897	35
30	2·504	5·008	7·511	10·015	12·519	15·023	17·527	20·030	22·534	25·038	30
35	2·518	5·036	7·554	10·071	12·589	15·107	17·625	20·143	22·661	25·179	25
40	2·532	5·064	7·596	10·128	12·660	15·192	17·724	20·256	22·788	25·319	20
45	2·546	5·092	7·638	10·184	12·730	15·276	17·822	20·368	22·914	25·460	15
50	2·560	5·120	7·680	10·240	12·800	15·360	17·920	20·481	23·041	25·601	10
55	2·574	5·148	7·722	10·296	12·871	15·445	18·019	20·593	23·167	25·741	5
60	2·588	5·176	7·764	10·353	12·941	15·529	18·117	20·705	23·294	25·882	75° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

75 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
15° 0′	·96593	60′
1	·96585	59
2	·96577	58
3	·96570	57
4	·96562	56
5	·96555	55
6	·96547	54
7	·96540	53
8	·96532	52
9	·96524	51
10	·96517	50
11	·96509	49
12	·96502	48
13	·96494	47
14	·96486	46
15	·96479	45
16	·96471	44
17	·96463	43
18	·96456	42
19	·96448	41
20	·96440	40
21	·96433	39
22	·96425	38
23	·96417	37
24	·96409	36
25	·96402	35
26	·96394	34
27	·96386	33
28	·96378	32
29	·96371	31
30	·96363	30
31	·96355	29
32	·96347	28
33	·96340	27
34	·96332	26
35	·96324	25
36	·96316	24
37	·96308	23
38	·96301	22
39	·96293	21
40	·96285	20
41	·96277	19
42	·96269	18
43	·96261	17
44	·96253	16
45	·96245	15
46	·96238	14
47	·96230	13
48	·96222	12
49	·96214	11
50	·96206	10
51	·96198	9
52	·96190	8
53	·96182	7
54	·96174	6
55	·96166	5
56	·96158	4
57	·96150	3
58	·96142	2
59	·96134	1
60	·96126	0 74°
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

15 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
15° 0′	9·659	19·318	28·978	38·637	48·296	57·955	67·614	77·274	86·933	96·592	60′
5	9·655	19·311	28·966	38·622	48·277	57·933	67·588	77·244	86·899	96·555	55
10	9·652	19·303	28·955	38·607	48·258	57·910	67·562	77·214	86·865	96·517	50
15	9·648	19·296	28·944	38·592	48·239	57·887	67·535	77·183	86·831	96·479	45
20	9·644	19·288	28·932	38·576	48·220	57·864	67·508	77·152	86·796	96·440	40
25	9·640	19·280	28·921	38·561	48·201	57·841	67·481	77·122	86·762	96·402	35
30	9·636	19·273	28·909	38·545	48·181	57·818	67·454	77·090	86·726	96·363	30
35	9·632	19·265	28·897	38·529	48·162	57·794	67·427	77·059	86·691	96·324	25
40	9·628	19·257	28·885	38·514	48·142	57·771	67·399	77·028	86·656	96·285	20
45	9·624	19·249	28·873	38·498	48·122	57·747	67·371	76·996	86·620	96·245	15
50	9·621	19·241	28·862	38·482	48·103	57·724	67·344	76·965	86·585	96·206	10
55	9·617	19·233	28·850	38·466	48 083	57·700	67·316	76·933	86·549	96·166	5
60	9·613	19·225	28·838	38·450	48·063	57·676	67·288	76·901	86·513	96·126	74° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

74 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
15° 0′	·25882	60′
1	·25910	59
2	·25938	58
3	·25966	57
4	·25994	56
5	·26022	55
6	·26050	54
7	·26078	53
8	·26107	52
9	·26135	51
10	·26163	50
11	·26191	49
12	·26219	48
13	·26247	47
14	·26275	46
15	·26303	45
16	·26331	44
17	·26359	43
18	·26387	42
19	·26415	41
20	·26443	40
21	·26471	39
22	·26499	38
23	·26528	37
24	·26556	36
25	·26584	35
26	·26612	34
27	·26640	33
28	·26668	32
29	·26696	31
30	·26724	30
31	·26752	29
32	·26780	28
33	·26808	27
34	·26836	26
35	·26864	25
36	·26892	24
37	·26920	23
38	·26948	22
39	·26976	21
40	·27004	20
41	·27032	19
42	·27060	18
43	·27088	17
44	·27116	16
45	·27144	15
46	·27172	14
47	·27200	13
48	·27228	12
49	·27256	11
50	·27284	10
51	·27312	9
52	·27340	8
53	·27368	7
54	·27396	6
55	·27424	5
56	·27452	4
57	·27480	3
58	·27508	2
59	·27536	1
60	·27564	0 74
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

15 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
15° 0′	2·588	5·176	7·764	10·353	12·941	15·529	18·117	20·705	23·294	25·882	60′
5	2·602	5·204	7·807	10·409	13·011	15·613	18·216	20·818	23·420	26·022	55
10	2·616	5·232	7·849	10·465	13·081	15·698	18·314	20·930	23·546	26·163	50
15	2·630	5·261	7·891	10·521	13·152	15·782	18·412	21·042	23·673	26·303	45
20	2·644	5·289	7·933	10·577	13·222	15·866	18·510	21·155	23·799	26·443	40
25	2·658	5·317	7·975	10·633	13·292	15·950	18·608	21·267	23·925	26·584	35
30	2·672	5·345	8·017	10·689	13·362	16·034	18·707	21·379	24·051	26·723	30
35	2·686	5·373	8·059	10·746	13·432	16·118	18·805	21·491	24·178	26·864	25
40	2·700	5·401	8·101	10·802	13·502	16·202	18·903	21·603	24·304	27·004	20
45	2·714	5·429	8·143	10·858	13·572	16·286	19·001	21·715	24·430	27·144	15
50	2·728	5·457	8·185	10·914	13·642	16·370	19·099	21·827	24·556	27·284	10
55	2·742	5·485	8·227	10·970	13·712	16·454	19·197	21·939	24·682	27·424	5
60	2·756	5·513	8·269	11·026	13·782	16·538	19·295	22·051	24·808	27·564	74° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

74 Deg. Latitudes, or Horizontal Distances for Difference of Levels

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
16° 0'	·96126	60'
1	·96118	59
2	·96110	58
3	·96102	57
4	·96094	56
5	·96086	55
6	·96078	54
7	·96070	53
8	·96062	52
9	·96054	51
10	·96046	50
11	·96037	49
12	·96029	48
13	·96021	47
14	·96013	46
15	·96005	45
16	·95997	44
17	·95989	43
18	·95980	42
19	·95972	41
20	·95964	40
21	·95956	39
22	·95948	38
23	·95940	37
24	·95931	36
25	·95923	35
26	·95915	34
27	·95907	33
28	·95898	32
29	·95890	31
30	·95882	30
31	·95874	29
32	·95865	28
33	·95857	27
34	·95849	26
35	·95841	25
36	·95832	24
37	·95824	23
38	·95816	22
39	·95807	21
40	·95799	20
41	·95791	19
42	·95782	18
43	·95774	17
44	·95765	16
45	·95757	15
46	·95749	14
47	·95740	13
48	·95732	12
49	·95723	11
50	·95715	10
51	·95707	9
52	·95698	8
53	·95690	7
54	·95681	6
55	·95673	5
56	·95664	4
57	·95656	3
58	·95647	2
59	·95639	1
60	·95630	0·73
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

16 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
16° 0'	9·613	19·225	28·838	38·450	48·063	57·676	67·288	76·901	86·513	96·126	60'
5	9·609	19·217	28·826	38·434	48·043	57·652	67·260	76·869	86·477	96·086	55
10	9·604	19·209	28·813	38·418	48·022	57·627	67·231	76·836	86·440	96·045	50
15	9·600	19·201	28·801	38·402	48·002	57·603	67·203	76·804	86·404	96·005	45
20	9·596	19·193	28·789	38·386	47·982	57·578	67·175	76·771	86·368	95·964	40
25	9·592	19·185	28·777	38·369	47·961	57·554	67·146	76·738	86·331	95·923	35
30	9·588	19·176	28·765	38·353	47·941	57·529	67·117	76·706	86·294	95·882	30
35	9·584	19·168	28·752	38·336	47·920	57·504	67·088	76·672	86·256	95·840	25
40	9·580	19·160	28·740	38·320	47·899	57·479	67·059	76·639	86·219	95·799	20
45	9·576	19·151	28·727	38·303	47·878	57·454	67·030	76·606	86·181	95·757	15
50	9·571	19·143	28·714	38·286	47·857	57·429	67·000	76·572	86·143	95·715	10
55	9·567	19·135	28·702	38·269	47·836	57·404	66·971	76·538	86·106	95·673	5
60	9·563	19·126	28·689	38·252	47·815	57·378	66·941	76·504	86·067	95·630	73° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

73 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
16° 0′	·27564	60′
1	·27592	59
2	·27620	58
3	·27648	57
4	·27676	56
5	·27703	55
6	·27731	54
7	·27759	53
8	·27787	52
9	·27815	51
10	·27843	50
11	·27871	49
12	·27899	48
13	·27927	47
14	·27955	46
15	·27983	45
16	·28011	44
17	·28039	43
18	·28067	42
19	·28095	41
20	·28122	40
21	·28150	39
22	·28178	38
23	·28206	37
24	·28234	36
25	·28262	35
26	·28290	34
27	·28318	33
28	·28346	32
29	·28374	31
30	·28401	30
31	·28429	29
32	·28457	28
33	·28485	27
34	·28513	26
35	·28541	25
36	·28569	24
37	·28597	23
38	·28625	22
39	·28652	21
40	·28680	20
41	·28708	19
42	·28736	18
43	·28764	17
44	·28792	16
45	·28820	15
46	·28847	14
47	·28875	13
48	·28903	12
49	·28931	11
50	·28959	10
51	·28987	9
52	·29014	8
53	·29042	7
54	·29070	6
55	·29098	5
56	·29126	4
57	·29154	3
58	·29181	2
59	·29209	1
60	·29237	0 73
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

16 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
16° 0′	2·756	5·513	8·269	11·026	13·782	16·538	19·295	22·051	24·808	27·564	60′
5	2·770	5·541	8·311	11·081	13·851	16·622	19·392	22·162	24·933	27·703	55
10	2·784	5·569	8·353	11·137	13·921	16·706	19·490	22·274	25·059	27·843	50
15	2·798	5·597	8·395	11·193	13·991	16·790	19·588	22·386	25·185	27·983	45
20	2·812	5·624	8·437	11·249	14·061	16·873	19·686	22·498	25·310	28·122	40
25	2·826	5·652	8·479	11·305	14·131	16·957	19·783	22·609	25·436	28·262	35
30	2·840	5·680	8·520	11·361	14·201	17·041	19·881	22·721	25·561	28·401	30
35	2·854	5·708	8·562	11·416	14·270	17·125	19·979	22·833	25·687	28·541	25
40	2·868	5·736	8·604	11·472	14·340	17·208	20·076	22·944	25·812	28·680	20
45	2·882	5·764	8·646	11·528	14·410	17·292	20·174	23·056	25·938	28·820	15
50	2·896	5·792	8·688	11·583	14·479	17·375	20·271	23·167	26·063	28·959	10
55	2·910	5·820	8·729	11·639	14·549	17·459	20·369	23·278	26·188	29·098	5
60	2·924	5·847	8·771	11·695	14·619	17·542	20·466	23·390	26·313	29·237	73° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

73 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
17° 0′	·95630	60′
1	·95622	59
2	·95613	58
3	·95605	57
4	·95596	56
5	·95588	55
6	·95579	54
7	·95571	53
8	·95562	52
9	·95554	51
10	·95545	50
11	·95536	49
12	·95528	48
13	·95519	47
14	·95510	46
15	·95502	45
16	·95493	44
17	·95485	43
18	·95476	42
19	·95467	41
20	·95459	40
21	·95450	39
22	·95441	38
23	·95433	37
24	·95424	36
25	·95415	35
26	·95406	34
27	·95398	33
28	·95389	32
29	·95380	31
30	·95372	30
31	·95363	29
32	·95354	28
33	·95345	27
34	·95337	26
35	·95328	25
36	·95319	24
37	·95310	23
38	·95301	22
39	·95293	21
40	·95284	20
41	·95275	19
42	·95266	18
43	·95257	17
44	·95248	16
45	·95240	15
46	·95231	14
47	·95222	13
48	·95213	12
49	·95204	11
50	·95195	10
51	·95186	9
52	·95177	8
53	·95168	7
54	·95159	6
55	·95150	5
56	·95141	4
57	·95133	3
58	·95124	2
59	·95115	1
60	·95106	0′ 72°
	Sines	

Departures, or Difference of Levels

17 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
17° 0′	9·563	19·126	28·689	38·252	47·815	57·378	66·941	76·504	86·067	95·630	60′
5	9·559	19·118	28·676	38·235	47·794	57·353	66·912	76·470	86·029	95·588	55
10	9·554	19·109	28·663	38·218	47·772	57·327	66·881	76·436	85·990	95·545	50
15	9·550	19·100	28·650	38·201	47·751	57·301	66·851	76·402	85·952	95·502	45
20	9·546	19·092	28·638	38·184	47·729	57·275	66·821	76·367	85·913	95·459	40
25	9·541	19·083	28·624	38·166	47·707	57·249	66·790	76·332	85·873	95·415	35
30	9·537	19·074	28·612	38·149	47·686	57·223	66·760	76·298	85·835	95·372	30
35	9·533	19·066	28·598	38·131	47·664	57·197	66·730	76·262	85·795	95·328	25
40	9·528	19·057	28·585	38·114	47·642	57·170	66·699	76·227	85·755	95·284	20
45	9·524	19·048	28·572	38·095	47·619	57·143	66·667	76·191	85·715	95·239	15
50	9·519	19·039	28·558	38·078	47·597	57·117	66·636	76·156	85·675	95·195	10
55	9·515	19·030	28·545	38·060	47·575	57·090	66·605	76·120	85·635	95·150	5
60	9·511	19·021	28·532	38·042	47·553	57·064	66·574	76·085	85·595	95·106	72° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

72 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
17° 0′	·29237	60′
1	·29265	59
2	·29293	58
3	·29321	57
4	·29348	56
5	·29376	55
6	·29404	54
7	·29432	53
8	·29460	52
9	·29487	51
10	·29515	50
11	·29543	49
12	·29571	48
13	·29599	47
14	·29626	46
15	·29654	45
16	·29682	44
17	·29710	43
18	·29737	42
19	·29765	41
20	·29793	40
21	·29821	39
22	·29849	38
23	·29876	37
24	·29904	36
25	·29932	35
26	·29960	34
27	·29987	33
28	·30015	32
29	·30043	31
30	·30071	30
31	·30098	29
32	·30126	28
33	·30154	27
34	·30181	26
35	·30209	25
36	·30237	24
37	·30265	23
38	·30292	22
39	·30320	21
40	·30348	20
41	·30376	19
42	·30403	18
43	·30431	17
44	·30459	16
45	·30486	15
46	·30514	14
47	·30542	13
48	·30569	12
49	·30597	11
50	·30625	10
51	·30653	9
52	·30680	8
53	·30708	7
54	·30736	6
55	·30763	5
56	·30791	4
57	·30819	3
58	·30846	2
59	·30874	1
60	·30902	0° 72
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

17 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
17° 0′	2·924	5·847	8·771	11·695	14·619	17·542	20·466	23·390	26·313	29·237	60′
5	2·938	5·875	8·813	11·750	14·688	17·626	20·563	23·501	26·439	29·376	55
10	2·952	5·903	8·855	11·806	14·758	17·709	20·660	23·612	26·564	29·515	50
15	2·965	5·931	8·896	11·862	14·827	17·792	20·758	23·723	26·689	29·654	45
20	2·979	5·959	8·938	11·917	14·896	17·876	20·855	23·834	26·814	29·793	40
25	2·993	5·986	8·979	11·973	14·966	17·959	20·952	23·945	26·939	29·932	35
30	3·007	6·014	9·021	12·028	15·035	18·042	21·049	24·056	27·063	30·070	30
35	3·021	6·042	9·063	12·084	15·105	18·126	21·146	24·167	27·188	30·209	25
40	3·035	6·070	9·104	12·139	15·174	18·209	21·243	24·278	27·313	30·348	20
45	3·049	6·097	9·146	12·195	15·243	18·292	21·340	24·389	27·438	30·486	15
50	3·062	6·125	9·187	12·250	15·312	18·375	21·437	24·500	27·562	30·625	10
55	3·076	6·153	9·229	12·305	15·382	18·458	21·534	24·611	27·687	30·763	5
60	3·090	6·180	9·270	12·361	15·451	18·541	21·631	24·721	27·811	30·902	72° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

72 Deg. Latitudes, or Horizontal Distances for Difference of Levels

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
18° 0′	·95106	60′
1	·95097	59
2	·95088	58
3	·95079	57
4	·95070	56
5	·95061	55
6	·95052	54
7	·95042	53
8	·95033	52
9	·95024	51
10	·95015	50
11	·95006	49
12	·94997	48
13	·94988	47
14	·94979	46
15	·94970	45
16	·94961	44
17	·94952	43
18	·94943	42
19	·94933	41
20	·94924	40
21	·94915	39
22	·94906	38
23	·94897	37
24	·94888	36
25	·94878	35
26	·94869	34
27	·94860	33
28	·94851	32
29	·94842	31
30	·94832	30
31	·94823	29
32	·94814	28
33	·94805	27
34	·94795	26
35	·94786	25
36	·94777	24
37	·94768	23
38	·94758	22
39	·94749	21
40	·94740	20
41	·94730	19
42	·94721	18
43	·94712	17
44	·94702	16
45	·94693	15
46	·94684	14
47	·94674	13
48	·94665	12
49	·94656	11
50	·94646	10
51	·94637	9
52	·94627	8
53	·94618	7
54	·94608	6
55	·94599	5
56	·94590	4
57	·94580	3
58	·94571	2
59	·94561	1
60	·94552	0° 71
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

18 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
18° 0′	9·511	19·021	28·532	38·042	47·553	57·064	66·574	76·085	85·595	95·106	60′
5	9·506	19·012	28·518	38·024	47·530	57·037	66·543	76·049	85·555	95·061	55
10	9·501	19·003	28·504	38·006	47·507	57·009	66·510	76·012	85·513	95·015	50
15	9·497	18·994	28·491	37·988	47·485	56·982	66·479	75·976	85·473	94·970	45
20	9·492	18·985	28·477	37·969	47·462	56·954	66·447	75·939	85·431	94·924	40
25	9·488	18·976	28·463	37·951	47·439	56·927	66·415	75·902	85·390	94·878	35
30	9·483	18·966	28·450	37·933	47·416	56·899	66·382	75·865	85·349	94·832	30
35	9·478	18·957	28·436	37·914	47·393	56·872	66·350	75·829	85·307	94·786	25
40	9·474	18·948	28·422	37·896	47·370	56·844	66·318	75·792	85·266	94·740	20
45	9·469	18·938	28·408	37·877	47·346	56·816	66·285	75·754	85·224	94·693	15
50	9·465	18·929	28·394	37·858	47·323	56·788	66·252	75·717	85·181	94·646	10
55	9·460	18·920	28·380	37·840	47·299	56·759	66·219	75·679	85·139	94·599	5
60	9·455	18·910	28·366	37·821	47·276	56·731	66·186	75·642	85·097	94·552	71° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

71 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels		
	Sines	
18° 0′	·30902	60′
1	·30929	59
2	·30957	58
3	·30985	57
4	·31012	56
5	·31040	55
6	·31068	54
7	·31095	53
8	·31123	52
9	·31151	51
10	·31178	50
11	·31206	49
12	·31233	48
13	·31261	47
14	·31289	46
15	·31316	45
16	·31344	44
17	·31372	43
18	·31399	42
19	·31427	41
20	·31454	40
21	·31482	39
22	·31510	38
23	·31537	37
24	·31565	36
25	·31592	35
26	·31620	34
27	·31648	33
28	·31675	32
29	·31703	31
30	·31730	30
31	·31758	29
32	·31786	28
33	·31813	27
34	·31841	26
35	·31868	25
36	·31896	24
37	·31923	23
38	·31951	22
39	·31979	21
40	·32006	20
41	·32034	19
42	·32061	18
43	·32089	17
44	·32116	16
45	·32144	15
46	·32171	14
47	·32199	13
48	·32227	12
49	·32254	11
50	·32282	10
51	·32309	9
52	·32337	8
53	·32364	7
54	·32392	6
55	·32419	5
56	·32447	4
57	·32474	3
58	·32502	2
59	·32529	1
60	·32557	0° 71′
	Cosines	
Latitudes, or Horizontal Distances for Difference of Levels		

DEPARTURES, OR DIFFERENCE OF LEVELS

18 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
18° 0′	3·090	6·180	9·270	12·361	15·451	18·541	21·631	24·721	27·811	30·902	60′
5	3·104	6·208	9·312	12·416	15·520	18·624	21·728	24·832	27·936	31·040	55
10	3·118	6·236	9·353	12·471	15·589	18·707	21·825	24·943	28·060	31·178	50
15	3·132	6·263	9·395	12·526	15·658	18·790	21·921	25·053	28·185	31·316	45
20	3·145	6·291	9·436	12·582	15·727	18·873	22·018	25·164	28·309	31·454	40
25	3·159	6·318	9·478	12·637	15·796	18·955	22·115	25·274	28·433	31·592	35
30	3·173	6·346	9·519	12·692	15·865	19·038	22·211	25·384	28·557	31·730	30
35	3·187	6·374	9·560	12·747	15·934	19·121	22·308	25·495	28·681	31·868	25
40	3·201	6·401	9·602	12·802	16·003	19·204	22·404	25·605	28·806	32·006	20
45	3·214	6·429	9·643	12·858	16·072	19·286	22·501	25·715	28·929	32·144	15
50	3·228	6·456	9·684	12·913	16·141	19·369	22·597	25·825	29·053	32·282	10
55	3·242	6·484	9·726	12·968	16·210	19·452	22·693	25·935	29·177	32·419	5
60	3·256	6·511	9·767	13·023	16·278	19·534	22·790	26·045	29·301	32·557	71° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

71 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
19° 0′	·94552	60′
1	·94542	59
2	·94533	58
3	·94523	57
4	·94514	56
5	·94504	55
6	·94495	54
7	·94485	53
8	·94476	52
9	·94466	51
10	·94457	50
11	·94447	49
12	·94438	48
13	·94428	47
14	·94418	46
15	·94409	45
16	·94399	44
17	·94390	43
18	·94380	42
19	·94370	41
20	·94361	40
21	·94351	39
22	·94342	38
23	·94332	37
24	·94322	36
25	·94313	35
26	·94303	34
27	·94293	33
28	·94284	32
29	·94274	31
30	·94264	30
31	·94254	29
32	·94245	28
33	·94235	27
34	·94225	26
35	·94215	25
36	·94206	24
37	·94196	23
38	·94186	22
39	·94176	21
40	·94167	20
41	·94157	19
42	·94147	18
43	·94137	17
44	·94127	16
45	·94118	15
46	·94108	14
47	·94098	13
48	·94088	12
49	·94078	11
50	·94068	10
51	·94058	9
52	·94049	8
53	·94039	7
54	·94029	6
55	·94019	5
56	·94009	4
57	·93999	3
58	·93989	2
59	·93979	1
60	·93969	0° 70
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

19 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
19° 0′	9·455	18·910	28·366	37·821	47·276	56·731	66·186	75·642	85·097	94·552	60′
5	9·450	18·901	28·351	37·802	47·252	56·702	66·153	75·603	85·053	94·504	55
10	9·446	18·891	28·337	37·783	47·228	56·674	66·120	75·566	85·011	94·457	50
15	9·441	18·882	28·323	37·764	47·204	56·645	66·086	75·527	84·968	94·409	45
20	9·436	18·872	28·308	37·744	47·180	56·617	66·053	75·489	84·925	94·361	40
25	9·431	18·863	28·294	37·725	47·156	56·588	66·019	75·450	84·882	94·313	35
30	9·426	18·853	28·279	37·706	47·132	56·558	65·985	75·411	84·838	94·264	30
35	9·421	18·843	28·264	37·686	47·107	56·529	65·950	75·372	84·793	94·215	25
40	9·417	18·833	28·250	37·667	47·083	56·500	65·917	75·334	84·750	94·167	20
45	9·412	18·824	28·235	37·647	47·059	56·471	65·883	75·294	84·706	94·118	15
50	9·407	18·814	28·220	37·627	47·034	56·441	65·848	75·254	84·661	94·068	10
55	9·402	18·804	28·206	37·608	47·009	56·411	65·813	75·215	84·617	94·019	5
60	9·397	18·794	28·191	37·588	46·984	56·381	65·778	75·175	84·572	93·969	70° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

70 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

19°	Sines	
0'	·32557	60'
1	·32584	59
2	·32612	58
3	·32639	57
4	·32667	56
5	·32694	55
6	·32722	54
7	·32749	53
8	·32777	52
9	·32804	51
10	·32832	50
11	·32859	49
12	·32887	48
13	·32914	47
14	·32942	46
15	·32969	45
16	·32996	44
17	·33024	43
18	·33051	42
19	·33079	41
20	·33106	40
21	·33134	39
22	·33161	38
23	·33189	37
24	·33216	36
25	·33243	35
26	·33271	34
27	·33298	33
28	·33326	32
29	·33353	31
30	·33381	30
31	·33408	29
32	·33435	28
33	·33463	27
34	·33490	26
35	·33518	25
36	·33545	24
37	·33573	23
38	·33600	22
39	·33627	21
40	·33655	20
41	·33682	19
42	·33709	18
43	·33737	17
44	·33764	16
45	·33792	15
46	·33819	14
47	·33846	13
48	·33874	12
49	·33901	11
50	·33928	10
51	·33956	9
52	·33983	8
53	·34011	7
54	·34038	6
55	·34065	5
56	·34093	4
57	·34120	3
58	·34147	2
59	·34175	1
60	·34202	0° 70
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

19 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
19° 0'	3·256	6·511	9·767	13·023	16·278	19·534	22·790	26·045	29·301	32·557	60'
5	3·269	6·539	9·808	13·078	16·347	19·617	22·886	26·155	29·425	32·694	55
10	3·283	6·566	9·849	13·133	16·416	19·699	22·982	26·265	29·548	32·832	50
15	3·297	6·594	9·891	13·188	16·484	19·781	23·078	26·375	29·672	32·969	45
20	3·311	6·621	9·932	13·242	16·554	19·864	23·174	26·485	29·796	33·106	40
25	3·324	6·649	9·973	13·297	16·622	19·946	23·270	26·595	29·919	33·243	35
30	3·338	6·676	10·014	13·352	16·690	20·028	23·366	26·704	30·043	33·381	30
35	3·352	6·703	10·055	13·407	16·759	20·111	23·462	26·814	30·166	33·518	25
40	3·365	6·731	10·096	13·462	16·827	20·193	23·558	26·924	30·289	33·655	20
45	3·379	6·758	10·137	13·517	16·896	20·275	23·654	27·033	30·412	33·792	15
50	3·393	6·786	10·178	13·571	16·964	20·357	23·750	27·143	30·536	33·928	10
55	3·406	6·813	10·219	13·626	17·032	20·439	23·846	27·252	30·659	34·065	5
60	3·420	6·840	10·261	13·681	17·101	20·521	23·941	27·362	30·782	34·202	70° 0
	10	20	30	40	50	60	70	80	90	100	

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

70 Deg. Latitudes, or Horizontal Distances for Difference of Levels

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
20° 0'	·93969	60'
1	·93959	59
2	·93949	58
3	·93939	57
4	·93929	56
5	·93919	55
6	·93909	54
7	·93899	53
8	·93889	52
9	·93879	51
10	·93869	50
11	·93859	49
12	·93849	48
13	·93839	47
14	·93829	46
15	·93819	45
16	·93809	44
17	·93799	43
18	·93789	42
19	·93779	41
20	·93769	40
21	·93759	39
22	·93748	38
23	·93738	37
24	·93728	36
25	·93718	35
26	·93708	34
27	·93698	33
28	·93688	32
29	·93677	31
30	·93667	30
31	·93657	29
32	·93647	28
33	·93637	27
34	·93626	26
35	·93616	25
36	·93606	24
37	·93596	23
38	·93585	22
39	·93575	21
40	·93565	20
41	·93555	19
42	·93544	18
43	·93534	17
44	·93524	16
45	·93513	15
46	·93503	14
47	·93493	13
48	·93483	12
49	·93472	11
50	·93462	10
51	·93451	9
52	·93441	8
53	·93431	7
54	·93420	6
55	·93410	5
56	·93400	4
57	·93389	3
58	·93379	2
59	·93368	1
60	·93358	0 ·69
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

20 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
20° 0'	9·397	18·794	28·191	37·588	46·984	56·381	65·778	75·175	84·572	93·969	60'
5	9·392	18·784	28·176	37·568	46·959	56·351	65·743	75·135	84·527	93·919	55
10	9·387	18·774	28·161	37·548	46·934	56·321	65·708	75·095	84·482	93·869	50
15	9·382	18·764	28·146	37·528	46·909	56·291	65·673	75·055	84·437	93·819	45
20	9·377	18·754	28·131	37·508	46·884	56·261	65·638	75·015	84·392	93·769	40
25	9·372	18·744	28·115	37·487	46·859	56·231	65·603	74·974	84·346	93·718	35
30	9·367	18·733	28·100	37·467	46·833	56·200	65·567	74·934	84·300	93·667	30
35	9·362	18·723	28·085	37·446	46·808	56·170	65·531	74·893	84·254	93·616	25
40	9·356	18·713	28·069	37·426	46·782	56·139	65·495	74·852	84·208	93·565	20
45	9·351	18·703	28·054	37·405	46·756	56·108	65·459	74·810	84·162	93·513	15
50	9·346	18·692	28·039	37·385	46·731	56·077	65·423	74·770	84·116	93·462	10
55	9·341	18·682	28·023	37·364	46·705	56·046	65·387	74·728	84·069	93·410	5
60	9·336	18·672	28·007	37·343	46·680	56·015	65·351	74·686	84·022	93·358	69° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

69 Deg. Departures, or Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

Departures, or Difference of Levels

	Sines	
20° 0'	·34202	60'
1	·34229	59
2	·34256	58
3	·34284	57
4	·34311	56
5	·34339	55
6	·34366	54
7	·34393	53
8	·34421	52
9	·34448	51
10	·34475	50
11	·34502	49
12	·34530	48
13	·34557	47
14	·34584	46
15	·34612	45
16	·34639	44
17	·34666	43
18	·34694	42
19	·34721	41
20	·34748	40
21	·34775	39
22	·34803	38
23	·34830	37
24	·34857	36
25	·34884	35
26	·34912	34
27	·34939	33
28	·34966	32
29	·34993	31
30	·35021	30
31	·35048	29
32	·35075	28
33	·35102	27
34	·35130	26
35	·35157	25
36	·35184	24
37	·35211	23
38	·35239	22
39	·35266	21
40	·35293	20
41	·35320	19
42	·35347	18
43	·35375	17
44	·35402	16
45	·35429	15
46	·35456	14
47	·35483	13
48	·35511	12
49	·35538	11
50	·35565	10
51	·35592	9
52	·35619	8
53	·35647	7
54	·35674	6
55	·35701	5
56	·35728	4
57	·35755	3
58	·35782	2
59	·35810	1
60	·35837	0 69°
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

20 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
20° 0'	3·420	6·840	10·261	13·681	17·101	20·521	23·941	27·362	30·782	34·202	60'
5	3·434	6·868	10·302	13·735	17·169	20·603	24·037	27·471	30·905	34·339	55
10	3·447	6·895	10·342	13·790	17·238	20·685	24·133	27·580	31·028	34·475	50
15	3·461	6·922	10·383	13·845	17·306	20·767	24·228	27·689	31·150	34·612	45
20	3·475	6·950	10·424	13·899	17·374	20·849	24·324	27·798	31·273	34·748	40
25	3·488	6·977	10·465	13·954	17·442	20·931	24·419	27·907	31·396	34·884	35
30	3·502	7·004	10·506	14·008	17·510	21·012	24·514	28·017	31·519	35·021	30
35	3·516	7·031	10·547	14·063	17·578	21·094	24·610	28·125	31·641	35·157	25
40	3·529	7·059	10·588	14·117	17·646	21·176	24·705	28·234	31·764	35·293	20
45	3·543	7·086	10·629	14·172	17·714	21·257	24·800	28·343	31·886	35·429	15
50	3·556	7·113	10·669	14·226	17·782	21·339	24·896	28·452	32·009	35·565	10
55	3·570	7·140	10·710	14·280	17·850	21·421	24·991	28·561	32·131	35·701	5
60	3·584	7·167	10·751	14·335	17·918	21·502	25·086	28·669	32·253	35·837	0 69°
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

69 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
21° 0′	·93358	60′
1	·93347	59
2	·93337	58
3	·93327	57
4	·93316	56
5	·93306	55
6	·93295	54
7	·93285	53
8	·93274	52
9	·93264	51
10	·93253	50
11	·93243	49
12	·93232	48
13	·93222	47
14	·93211	46
15	·93201	45
16	·93190	44
17	·93180	43
18	·93169	42
19	·93158	41
20	·93148	40
21	·93137	39
22	·93127	38
23	·93116	37
24	·93106	36
25	·93095	35
26	·93084	34
27	·93074	33
28	·93063	32
29	·93052	31
30	·93042	30
31	·93031	29
32	·93020	28
33	·93010	27
34	·92999	26
35	·92988	25
36	·92978	24
37	·92967	23
38	·92956	22
39	·92945	21
40	·92935	20
41	·92924	19
42	·92913	18
43	·92902	17
44	·92892	16
45	·92881	15
46	·92870	14
47	·92859	13
48	·92849	12
49	·92838	11
50	·92827	10
51	·92816	9
52	·92805	8
53	·92794	7
54	·92784	6
55	·92773	5
56	·92762	4
57	·92751	3
58	·92740	2
59	·92729	1
60	·92718	0·68
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

21 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
21° 0′	9·336	18·672	28·007	37·343	46·680	56·015	65·351	74·686	84·022	93·358	60′
5	9·331	18·661	27·992	37·322	46·653	55·984	65·314	74·645	83·975	93·306	55
10	9·325	18·651	27·976	37·301	46·626	55·952	65·277	74·602	83·928	93·253	50
15	9·320	18·640	27·960	37·280	46·600	55·920	65·241	74·561	83·881	93·201	45
20	9·315	18·630	27·944	37·259	46·574	55·889	66·204	74·518	83·833	93·148	40
25	9·309	18·619	27·928	37·238	46·547	55·857	65·166	74·476	83·785	93·095	35
30	9·304	18·608	27·913	37·217	46·521	55·825	65·129	74·434	83·738	93·042	30
35	9·299	18·598	27·896	37·195	46·494	55·793	65·092	74·390	83·689	92·988	25
40	9·293	18·587	27·880	37·174	46·467	55·761	65·054	74·348	83·641	92·935	20
45	9·288	18·576	27·864	37·152	46·440	55·729	65·017	74·305	83·593	92·881	15
50	9·283	18·565	27·848	37·131	46·413	55·696	64·979	74·262	83·544	92·827	10
55	9·277	18·555	27·832	37·109	46·386	55·664	64·941	74·218	83·496	92·773	5
60	9·272	18·544	27·815	37·087	46·359	55·631	64·903	74·174	83·446	92·718	68° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

68 Deg. Departures, or Difference of Levels.

Departures, or Difference of Levels

	Sines	
21° 0'	·35837	60'
1	·35864	59
2	·35891	58
3	·35918	57
4	·35945	56
5	·35972	55
6	·36000	54
7	·36027	53
8	·36054	52
9	·36081	51
10	·36108	50
11	·36135	49
12	·36162	48
13	·36190	47
14	·36217	46
15	·36244	45
16	·36271	44
17	·36298	43
18	·36325	42
19	·36352	41
20	·36379	40
21	·36406	39
22	·36433	38
23	·36461	37
24	·36488	36
25	·36515	35
26	·36542	34
27	·36569	33
28	·36596	32
29	·36623	31
30	·36650	30
31	·36677	29
32	·36704	28
33	·36731	27
34	·36758	26
35	·36785	25
36	·36812	24
37	·36839	23
38	·36866	22
39	·36894	21
40	·36921	20
41	·36948	19
42	·36975	18
43	·37002	17
44	·37029	16
45	·37056	15
46	·37083	14
47	·37110	13
48	·37137	12
49	·37164	11
50	·37191	10
51	·37218	9
52	·37245	8
53	·37272	7
54	·37299	6
55	·37326	5
56	·37353	4
57	·37380	3
58	·37407	2
59	·37434	1
60	·37461	0° 68
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

21 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
21° 0'	3·584	7·167	10·751	14·335	17·918	21·502	25·086	28·669	32·253	35·837	60'
5	3·597	7·194	10·792	14·389	17·986	21·583	25·181	28·778	32·375	35·972	55
10	3·611	7·222	10·832	14·443	18·054	21·665	25·276	28·887	32·497	36·108	50
15	3·624	7·249	10·873	14·497	18·122	21·746	25·371	28·995	32·619	36·244	45
20	3·638	7·276	10·914	14·552	18·190	21·828	25·465	29·103	32·741	36·379	40
25	3·651	7·303	10·954	14·606	18·257	21·909	25·560	29·212	32·863	36·515	35
30	3·665	7·330	10·995	14·660	18·325	21·990	25·655	29·320	32·985	36·650	30
35	3·678	7·357	11·036	14·714	18·393	22·071	25·750	29·428	33·107	36·785	25
40	3·692	7·384	11·076	14·768	18·460	22·152	25·844	29·536	33·228	36·921	20
45	3·706	7·411	11·117	14·822	18·528	22·233	25·939	29·645	33·350	37·056	15
50	3·719	7·438	11·157	14·876	18·595	22·314	26·033	29·753	33·472	37·191	10
55	3·733	7·465	11·198	14·930	18·663	22·395	26·128	29·860	33·593	37·326	5
60	3·746	7·492	11·238	14·984	18·730	22·476	26·222	29·968	33·715	37·460	68° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

68 Deg. Latitudes, or Horizontal Distances for Difference of Levels

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
22° 0′	·92718	60
1	·92707	59
2	·92697	58
3	·92686	57
4	·92675	56
5	·92664	55
6	·92653	54
7	·92642	53
8	·92631	52
9	·92620	51
10	·92609	50
11	·92598	49
12	·92587	48
13	·92576	47
14	·92565	46
15	·92554	45
16	·92543	44
17	·92532	43
18	·92521	42
19	·92510	41
20	·92499	40
21	·92488	39
22	·92477	38
23	·92466	37
24	·92455	36
25	·92443	35
26	·92432	34
27	·92421	33
28	·92410	32
29	·92399	31
30	·92388	30
31	·92377	29
32	·92366	28
33	·92354	27
34	·92343	26
35	·92332	25
36	·92321	24
37	·92310	23
38	·92299	22
39	·92287	21
40	·92276	20
41	·92265	19
42	·92254	18
43	·92243	17
44	·92231	16
45	·92220	15
46	·92209	14
47	·92198	13
48	·92186	12
49	·92175	11
50	·92164	10
51	·92152	9
52	·92141	8
53	·92130	7
54	·92118	6
55	·92107	5
56	·92096	4
57	·92085	3
58	·92073	2
59	·92062	1
60	·92050	0·67
	Sines	

Departures, or Difference of Levels

22 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
22° 0′	9·272	18·544	27·815	37·087	46·359	55·631	64·903	74·174	83·446	92·718	60′
5	9·266	18·533	27·779	37·066	46·332	55·598	64·865	74·131	83·398	92·664	55
10	9·261	18·522	27·783	37·044	46·304	55·565	64·826	74·087	83·348	92·609	50
15	9·255	18·511	27·766	37·022	46·277	55·532	64·788	74·043	83·299	92·554	45
20	9·250	18·500	27·750	37·000	46·249	55·499	64·749	73·999	83·249	92·499	40
25	9·244	18·489	27·733	36·997	46·221	55·466	64·710	73·954	83·199	92·443	35
30	9·239	18·478	27·716	36·955	46·194	55·433	64·672	73·910	83·149	92·388	30
35	9·233	18·466	27·700	36·933	46·166	55·399	64·632	73·865	83·099	92·332	25
40	9·228	18·455	27·683	36·910	46·138	55·366	64·593	73·821	83·048	92·276	20
45	9·222	18·444	27·666	36·888	46·110	55·332	64·554	73·776	82·998	92·220	15
50	9·216	18·433	27·649	36·866	46·082	55·298	64·515	73·731	82·948	92·164	10
55	9·211	18·421	27·632	36·843	46·053	55·264	64·475	73·686	82·896	92·107	5
60	9·205	18·410	27·615	36·820	46·025	55·230	64·435	73·640	82·845	92·050	67° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

67 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
22° 0′	·37461	60′
1	·37488	59
2	·37515	58
3	·37542	57
4	·37568	56
5	·37595	55
6	·37622	54
7	·37649	53
8	·37676	52
9	·37703	51
10	·37730	50
11	·37757	49
12	·37784	48
13	·37811	47
14	·37838	46
15	·37865	45
16	·37892	44
17	·37919	43
18	·37946	42
19	·37972	41
20	·37999	40
21	·38026	39
22	·38053	38
23	·38080	37
24	·38107	36
25	·38134	35
26	·38161	34
27	·38188	33
28	·38215	32
29	·38241	31
30	·38268	30
31	·38295	29
32	·38322	28
33	·38349	27
34	·38376	26
35	·38403	25
36	·38429	24
37	·38456	23
38	·38483	22
39	·38510	21
40	·38537	20
41	·38564	19
42	·38591	18
43	·38617	17
44	·38644	16
45	·38671	15
46	·38698	14
47	·38725	13
48	·38752	12
49	·38778	11
50	·38805	10
51	·38832	9
52	·38859	8
53	·38886	7
54	·38912	6
55	·38939	5
56	·38966	4
57	·38993	3
58	·39019	2
59	·39046	1
60	·39073	0·67
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

22 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
22° 0′	3·746	7·492	11·238	14·984	18·730	22·476	26·222	29·968	33·715	37·460	60′
5	3·760	7·519	11·279	15·038	18·798	22·557	26·317	30·076	33·835	37·595	55
10	3·773	7·546	11·319	15·092	18·865	22·638	26·411	30·184	33·957	37·730	50
15	3·786	7·573	11·359	15·146	18·932	22·719	26·505	30·292	34·078	37·865	45
20	3·800	7·600	11·400	15·200	19·000	22·800	26·600	30·400	34·199	37·999	40
25	3·813	7·627	11·440	15·254	19·067	22·880	26·694	30·507	34·320	38·134	35
30	3·826	7·654	11·480	15·307	19·134	22·961	26·788	30·615	34·441	38·268	30
35	3·840	7·680	11·521	15·361	19·201	23·042	26·882	30·722	34·562	38·403	25
40	3·854	7·707	11·561	15·415	19·268	23·122	26·976	30·829	34·683	38·537	20
45	3·867	7·734	11·601	15·468	19·335	23·203	27·070	30·937	34·804	38·671	15
50	3·880	7·761	11·641	15·522	19·402	23·283	27·164	31·044	34·925	38·805	10
55	3·894	7·788	11·682	15·576	19·470	23·363	27·257	31·141	35·045	38·939	5
60	3·907	7·815	11·722	15·629	19·537	23·444	27·351	31·258	35·166	39·073	67° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

67 Deg. Latitudes, or Horizontal Distances for Difference of Levels

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
23° 0'	·92050	60'
1	·92039	59
2	·92028	58
3	·92016	57
4	·92005	56
5	·91994	55
6	·91982	54
7	·91971	53
8	·91959	52
9	·91948	51
10	·91936	50
11	·91925	49
12	·91913	48
13	·91902	47
14	·91891	46
15	·91879	45
16	·91868	44
17	·91856	43
18	·91845	42
19	·91833	41
20	·91822	40
21	·91810	39
22	·91799	38
23	·91787	37
24	·91775	36
25	·91764	35
26	·91752	34
27	·91741	33
28	·91729	32
29	·91718	31
30	·91706	30
31	·91694	29
32	·91683	28
33	·91671	27
34	·91660	26
35	·91648	25
36	·91636	24
37	·91625	23
38	·91613	22
39	·91601	21
40	·91590	20
41	·91578	19
42	·91566	18
43	·91554	17
44	·91543	16
45	·91531	15
46	·91519	14
47	·91508	13
48	·91496	12
49	·91484	11
50	·91472	10
51	·91461	9
52	·91449	8
53	·91437	7
54	·91425	6
55	·91414	5
56	·91402	4
57	·91390	3
58	·91378	2
59	·91366	1
60	·91355	0 ·66
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

23 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
23° 0'	9·205	18·410	27·615	36·820	46·025	55·230	64·435	73·640	82·845	92·050	60'
5	9·199	18·399	27·598	36·797	45·996	55·196	64·395	73·594	82·794	91·993	55
10	9·194	18·387	27·581	36·774	45·968	55·162	64·355	73·549	82·742	91·936	50
15	9·188	18·376	27·564	36·752	45·939	55·127	64·315	73·503	82·691	91·879	45
20	9·182	18·364	27·547	36·729	45·911	55·093	64·275	73·458	82·640	91·822	40
25	9·176	18·353	27·529	36·706	45·882	55·058	64·235	73·411	82·588	91·764	35
30	9·171	18·341	27·512	36·682	45·853	55·024	64·194	73·365	82·535	91·706	30
35	9·165	18·330	27·494	36·659	45·824	54·989	64·154	73·318	82·483	91·648	25
40	9·159	18·318	27·477	36·636	45·795	54·954	64·113	73·272	82·431	91·590	20
45	9·153	18·306	27·459	36·612	45·765	54·919	64·072	73·225	82·378	91·531	15
50	9·147	18·294	27·442	36·589	45·736	54·883	64·030	73·178	82·325	91·472	10
55	9·141	18·283	27·424	36·566	45·707	54·848	63·990	73·131	82·273	91·414	5
60	9·135	18·271	27·406	36·542	45·677	54·812	63·948	73·083	82·219	91·354	66° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

66 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
23° 0'	·39073	60'
1	·39100	59
2	·39127	58
3	·39153	57
4	·39180	56
5	·39207	55
6	·39234	54
7	·39260	53
8	·39287	52
9	·39314	51
10	·39341	50
11	·39367	49
12	·39394	48
13	·39421	47
14	·39448	46
15	·39474	45
16	·39501	44
17	·39528	43
18	·39555	42
19	·39581	41
20	·39608	40
21	·39635	39
22	·39661	38
23	·39688	37
24	·39715	36
25	·39741	35
26	·39768	34
27	·39795	33
28	·39821	32
29	·39848	31
30	·39875	30
31	·39902	29
32	·39928	28
33	·39955	27
34	·39982	26
35	·40008	25
36	·40035	24
37	·40062	23
38	·40088	22
39	·40115	21
40	·40141	20
41	·40168	19
42	·40195	18
43	·40221	17
44	·40248	16
45	·40275	15
46	·40301	14
47	·40328	13
48	·40354	12
49	·40381	11
50	·40408	10
51	·40434	9
52	·40461	8
53	·40488	7
54	·40514	6
55	·40541	5
56	·40567	4
57	·40594	3
58	·40620	2
59	·40647	1
60	·40674	0·66
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

23 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
23° 0'	3·907	7·815	11·722	15·629	19·537	23·444	27·351	31·258	35·166	39·073	60'
5	3·921	7·841	11·762	15·683	19·603	23·524	27·445	31·366	35·286	39·207	55
10	3·934	7·868	11·802	15·736	19·670	23·604	27·538	31·473	35·407	39·341	50
15	3·947	7·895	11·842	15·789	19·737	23·685	27·632	31·579	35·527	39·474	45
20	3·961	7·922	11·882	15·843	19·804	23·765	27·726	31·686	35·647	39·608	40
25	3·974	7·948	11·922	15·897	19·871	23·845	27·819	31·793	35·767	39·741	35
30	3·987	7·975	11·962	15·950	19·937	23·925	27·912	31·900	35·887	39·875	30
35	4·001	8·002	12·003	16·003	20·004	24·005	28·006	32·007	36·007	40·008	25
40	4·014	8·028	12·042	16·057	20·071	24·085	28·099	32·113	36·127	40·141	20
45	4·027	8·055	12·082	16·110	20·137	24·165	28·192	32·220	36·247	40·275	15
50	4·041	8·082	12·122	16·163	20·204	24·245	28·285	32·326	36·367	40·408	10
55	4·054	8·108	12·162	16·216	20·270	24·324	28·378	32·433	36·487	40·541	5
60	4·067	8·135	12·202	16·269	20·337	24·404	28·471	32·539	36·606	40·674	66° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

66 Deg. Latitudes, or Horizontal Distances for Difference of Levels

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels	Cosines	
24° 0′	·91355	60′
1	·91343	59
2	·91331	58
3	·91319	57
4	·91307	56
5	·91295	55
6	·91283	54
7	·91271	53
8	·91260	52
9	·91248	51
10	·91236	50
11	·91224	49
12	·91212	48
13	·91200	47
14	·91188	46
15	·91176	45
16	·91164	44
17	·91152	43
18	·91140	42
19	·91128	41
20	·91116	40
21	·91104	39
22	·91092	38
23	·91080	37
24	·91068	36
25	·91056	35
26	·91044	34
27	·91032	33
28	·91020	32
29	·91008	31
30	·90996	30
31	·90984	29
32	·90972	28
33	·90960	27
34	·90948	26
35	·90936	25
36	·90924	24
37	·90911	23
38	·90899	22
39	·90887	21
40	·90875	20
41	·90863	19
42	·90851	18
43	·90839	17
44	·90826	16
45	·90814	15
46	·90802	14
47	·90790	13
48	·90778	12
49	·90765	11
50	·90753	10
51	·90741	9
52	·90729	8
53	·90717	7
54	·90704	6
55	·90692	5
56	·90680	4
57	·90668	3
58	·90655	2
59	·90643	1
60	·90631	0·65
	Sines	
Departures, or Difference of Levels		

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

24 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
24° 0′	9·135	18·271	27·406	36·542	45·677	54·812	63·948	73·083	82·219	91·354	60′
5	9·129	18·259	27·388	36·518	45· 47	54·777	63·906	73·036	82·165	91·295	55
10	9·124	18·247	27·371	36·494	45·618	54·742	63·865	72·989	82·112	91·236	50
15	9·118	18·235	27·353	36·470	45·588	54·706	63·823	72·941	82·058	91·176	45
20	9·112	18·223	27·335	36·446	45·558	54·670	63·781	72·893	82·004	91·116	40
25	9·106	18·211	27·317	36·422	45·528	54·634	63·739	72·845	81·950	91·056	35
30	9·100	18·199	27·299	36·398	45·498	54·598	63·697	72·797	81·896	90·996	30
35	9·094	18·187	27·281	36·374	45·468	54·562	63·655	72·749	81·842	90·936	25
40	9·087	18·175	27·262	36·350	45·437	54·525	63·612	72·700	81·787	90·875	20
45	9·081	18·163	27·244	36·3 6	45·407	54·488	63·570	72·651	81·733	90·814	15
50	9·075	18·151	27·226	36·301	45·376	54·452	63·527	72·602	81·678	90·753	10
55	9·069	18·138	27·208	36·277	45·346	54·415	63·484	72·554	81·623	90·692	5
60	9·063	18·126	27·189	36·252	45·315	54·378	63·442	72·505	81·568	90·631	0
											65°
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

65 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
24° 0′	·40674	60′
1	·40700	59
2	·40727	58
3	·40753	57
4	·40780	56
5	·40806	55
6	·40833	54
7	·40860	53
8	·40886	52
9	·40913	51
10	·40939	50
11	·40966	49
12	·40992	48
13	·41019	47
14	·41045	46
15	·41072	45
16	·41098	44
17	·41125	43
18	·41151	42
19	·41178	41
20	·41204	40
21	·41231	39
22	·41257	38
23	·41284	37
24	·41310	36
25	·41337	35
26	·41363	34
27	·41390	33
28	·41416	32
29	·41443	31
30	·41469	30
31	·41496	29
32	·41522	28
33	·41549	27
34	·41575	26
35	·41602	25
36	·41628	24
37	·41654	23
38	·41681	22
39	·41707	21
40	·41734	20
41	·41760	19
42	·41787	18
43	·41813	17
44	·41840	16
45	·41866	15
46	·41892	14
47	·41919	13
48	·41945	12
49	·41971	11
50	·41998	10
51	·42024	9
52	·42051	8
53	·42077	7
54	·42104	6
55	·42130	5
56	·42156	4
57	·42183	3
58	·42209	2
59	·42235	1
60	·42262	0·65°
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

24 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
24° 0′	4·067	8·135	12·202	16·269	20·337	24·404	28·471	32·539	36·606	40·674	60′
5	4·081	8·161	12·242	16·323	20·403	24·484	28·564	32·645	36·726	40·806	55
10	4·094	8·188	12·282	16·376	20·470	24·563	28·657	32·751	36·845	40·939	50
15	4·107	8·214	12·321	16·429	20·536	24·643	28·750	32·857	36·965	41·072	45
20	4·120	8·241	12·361	16·482	20·602	24·723	28·843	32·963	37·084	41·204	40
25	4·134	8·267	12·401	16·535	20·668	24·802	28·936	33·069	37·203	41·337	35
30	4·147	8·294	12·441	16·588	20·735	24·882	29·028	33·175	37·322	41·469	30
35	4·160	8·320	12·480	16·641	20·801	24·961	29·121	33·281	37·441	41·602	25
40	4·173	8·347	12·520	16·693	20·867	25·040	29·214	33·387	37·560	41·734	20
45	4·187	8·373	12·560	16·746	20·933	25·120	29·306	33·493	37·679	41·866	15
50	4·200	8·400	12·599	16·799	20·999	25·199	29·399	33·598	37·798	41·998	10
55	4·213	8·426	12·639	16·852	21·065	25·278	29·491	33·704	37·917	42·130	5
60	4·226	8·452	12·678	16·905	21·131	25·357	29·583	33·809	38·036	42·262	65° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

65 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
25° 0′	·90631	60′
1	·90618	59
2	·90606	58
3	·90594	57
4	·90581	56
5	·90569	55
6	·90557	54
7	·90544	53
8	·90522	52
9	·90520	51
10	·90507	50
11	·90495	49
12	·90483	48
13	·90470	47
14	·90458	46
15	·90445	45
16	·90433	44
17	·90421	43
18	·90408	42
19	·90396	41
20	·90383	40
21	·90371	39
22	·90358	38
23	·90346	37
24	·90333	36
25	·90321	35
26	·90309	34
27	·90296	33
28	·90284	32
29	·90271	31
30	·90258	30
31	·90246	29
32	·90233	28
33	·90221	27
34	·90208	26
35	·90196	25
36	·90183	24
37	·90171	23
38	·90158	22
39	·90145	21
40	·90133	20
41	·90120	19
42	·90108	18
43	·90095	17
44	·90082	16
45	·90070	15
46	·90057	14
47	·90044	13
48	·90032	12
49	·90019	11
50	·90006	10
51	·89994	9
52	·89981	8
53	·89968	7
54	·89956	6
55	·89943	5
56	·89930	4
57	·89918	3
58	·89905	2
59	·89892	1
60	·89879	0 ·64
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

25 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
25° 0′	9·063	18·126	27·189	36·252	45·315	54·378	63·442	72·505	81·568	90·631	60′
5	9·057	18·114	27·171	36·228	45·284	54·341	63·398	72·455	81·512	90·569	55
10	9·051	18·101	27·152	36·203	45·253	54·304	63·355	72·406	81·456	90·507	50
15	9·044	18·089	27·133	36·178	45·222	54·267	63·311	72·356	81·400	90·445	45
20	9·038	18·077	27·115	36·153	45·191	54·230	63·268	72·306	81·345	90·383	40
25	9·032	18·064	27·096	36·128	45·160	54·193	63·225	72·257	81·289	90·321	35
30	9·026	18·052	27·077	36·103	45·129	54·155	63·181	72·206	81·232	90·258	30
35	9·020	18·039	27·059	36·078	45·098	54·118	63·137	72·157	81·176	90·196	25
40	9·013	18·027	27·040	36·053	45·066	54·080	63·093	72·106	81·120	90·133	20
45	9·007	18·014	27·021	36·028	45·035	54·042	63·049	72·056	81·063	90·070	15
50	9·001	18·001	27·002	36·002	45·003	54·004	63·004	72·005	81·005	90·006	10
55	8·994	17·989	26·983	35·997	44·971	53·966	62·960	71·954	80·949	89·943	5
60	8·988	17·976	26·964	35·952	44·939	53·927	62·915	71·903	80·891	89·879	64° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

64 Deg. Departures, or Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

Departures, or Difference of Levels

	Sines	
25° 0′	·42262	60′
1	·42288	59
2	·42314	58
3	·42341	57
4	·42367	56
5	·42394	55
6	·42420	54
7	·42446	53
8	·42473	52
9	·42499	51
10	·42525	50
11	·42552	49
12	·42578	48
13	·42604	47
14	·42631	46
15	·42657	45
16	·42683	44
17	·42709	43
18	·42736	42
19	·42762	41
20	·42788	40
21	·42815	39
22	·42841	38
23	·42867	37
24	·42893	36
25	·42920	35
26	·42946	34
27	·42972	33
28	·42999	32
29	·43025	31
30	·43051	30
31	·43077	29
32	·43104	28
33	·43130	27
34	·43156	26
35	·43182	25
36	·43209	24
37	·43235	23
38	·43261	22
39	·43287	21
40	·43313	20
41	·43340	19
42	·43366	18
43	·43392	17
44	·43418	16
45	·43444	15
46	·43471	14
47	·43497	13
48	·43523	12
49	·43549	11
50	·43575	10
51	·43602	9
52	·43628	8
53	·43654	7
54	·43680	6
55	·43706	5
56	·43732	4
57	·43759	3
58	·43785	2
59	·43811	1
60	·43837	0 64°
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

25 Deg. Departures, or Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
25° 0′	4·226	8·452	12·678	16·905	21·131	25·357	29·583	33·809	38·036	42·262	60′
5	4·239	8·479	12·718	16·957	21·197	25·436	29·675	33·915	38·154	42·394	55
10	4·252	8·505	12·758	17·010	21·263	25·515	29·768	34·020	38·273	42·525	50
15	4·266	8·531	12·797	17·063	21·328	25·594	29·860	34·125	38·392	42·657	45
20	4·279	8·558	12·836	17·115	21·394	25·673	29·952	34·231	38·509	42·788	40
25	4·292	8·584	12·876	17·168	21·460	25·752	30·044	34·336	38·628	42·920	35
30	4·305	8·610	12·915	17·220	21·526	25·831	30·136	34·441	38·746	43·051	30
35	4·318	8·636	12·955	17·273	21·591	25·909	30·228	34·546	38·864	43·182	25
40	4·331	8·663	12·994	17·325	21·657	25·988	30·319	34·651	38·982	43·313	20
45	4·344	8·689	13·033	17·378	21·722	26·067	30·411	34·756	39·100	43·444	15
50	4·357	8·715	13·073	17·430	21·788	26·145	30·503	34·860	39·218	43·575	10
55	4·371	8·741	13·112	17·482	21·853	26·224	30·594	34·965	39·336	43·706	5
60	4·384	8·767	13·151	17·535	21·918	26·302	30·686	35·070	39·453	43·837	64° 0
	10	20	30	40	50	60	70	80	90	100	Measured Length

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

64 Deg. Latitudes, or Horizontal Distances for Difference of Levels

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
26° 0'	·89879	60'
1	·89866	59
2	·89854	58
3	·89841	57
4	·89828	56
5	·89815	55
6	·89803	54
7	·89790	53
8	·89777	52
9	·89764	51
10	·89751	50
11	·89739	49
12	·89726	48
13	·89713	47
14	·89700	46
15	·89687	45
16	·89674	44
17	·89661	43
18	·89649	42
19	·89636	41
20	·89623	40
21	·89610	39
22	·89597	38
23	·89584	37
24	·89571	36
25	·89558	35
26	·89545	34
27	·89532	33
28	·89519	32
29	·89506	31
30	·89493	30
31	·89480	29
32	·89467	28
33	·89454	27
34	·89441	26
35	·89428	25
36	·89415	24
37	·89402	23
38	·89389	22
39	·89376	21
40	·89363	20
41	·89350	19
42	·89337	18
43	·89324	17
44	·89311	16
45	·89298	15
46	·89285	14
47	·89272	13
48	·89259	12
49	·89245	11
50	·89232	10
51	·89219	9
52	·89206	8
53	·89193	7
54	·89180	6
55	·89167	5
56	·89153	4
57	·89140	3
58	·89127	2
59	·89114	1
60	·89101	0·63
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

26 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
26° 0'	8·988	17·976	26·964	35·952	44·939	53·927	62·915	71·903	80·891	89·879	60'
5	8·981	17·963	26·944	35·926	44·907	53·889	62·870	71·852	80·833	89·815	55
10	8·975	17·950	26·925	35·900	44·875	53·851	62·826	71·801	80·776	89·751	50
15	8·969	17·937	26·906	35·875	44·843	53·812	62·781	71·750	80·718	89·687	45
20	8·962	17·925	26·887	35·849	44·811	53·774	62·736	71·698	80·661	89·623	40
25	8·956	17·912	26·867	35·823	44·779	53·735	62·691	71·646	80·602	89·558	35
30	8·949	17·899	26·848	35·797	44·746	53·696	62·645	71·594	80·544	89·493	30
35	8·943	17·886	26·828	35·771	44·714	53·657	62·600	71·542	80·485	89·428	25
40	8·936	17·873	26·809	35·745	44·681	53·618	62·554	71·490	80·427	89·363	20
45	8·930	17·860	26·789	35·719	44·649	53·579	62·509	71·438	80·368	89·298	15
50	8·923	17·846	26·769	35·693	44·616	53·539	62·462	71·385	80·309	89·232	10
55	8·917	17·833	26·750	35·666	44·583	53·500	62·416	71·333	80·249	89·166	5
60	8·910	17·820	26·730	35·640	44·550	53·461	62·371	71·281	80·191	89·101	63° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

63 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
26° 0′	·43837	60′
1	·43863	59
2	·43889	58
3	·43915	57
4	·43942	56
5	·43968	55
6	·43994	54
7	·44020	53
8	·44046	52
9	·44072	51
10	·44098	50
11	·44124	49
12	·44151	48
13	·44177	47
14	·44203	46
15	·44229	45
16	·44255	44
17	·44281	43
18	·44307	42
19	·44333	41
20	·44359	40
21	·44385	39
22	·44411	38
23	·44437	37
24	·44463	36
25	·44490	35
26	·44516	34
27	·44542	33
28	·44568	32
29	·44594	31
30	·44620	30
31	·44646	29
32	·44672	28
33	·44698	27
34	·44724	26
35	·44750	25
36	·44776	24
37	·44802	23
38	·44828	22
39	·44854	21
40	·44880	20
41	·44906	19
42	·44932	18
43	·44958	17
44	·44984	16
45	·45010	15
46	·45036	14
47	·45062	13
48	·45088	12
49	·45114	11
50	·45140	10
51	·45166	9
52	·45192	8
53	·45217	7
54	·45243	6
55	·45269	5
56	·45295	4
57	·45321	3
58	·45347	2
59	·45373	1
60	·45399	0 ·63
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

26 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
26° 0′	4·384	8·767	13·151	17·535	21·918	26·302	30·686	35·070	39·453	43·837	60′
5	4·397	8·793	13·190	17·587	21·984	26·381	30·777	35·174	39·571	43·968	55
10	4·410	8·820	13·229	17·639	22·049	26·459	30·869	35·279	39·688	44·098	50
15	4·423	8·846	13·269	17·691	22·114	26·537	30·960	35·383	39·806	44·229	45
20	4·436	8·872	13·308	17·744	22·180	26·616	31·051	35·487	39·923	44·359	40
25	4·449	8·898	13·347	17·796	22·245	26·694	31·143	35·592	40·041	44·490	35
30	4·462	8·924	13·386	17·848	22·310	26·772	31·234	35·696	40·158	44·620	30
35	4·475	8·950	13·425	17·900	22·375	26·850	31·325	35·800	40·275	44·750	25
40	4·488	8·976	13·464	17·952	22·440	26·928	31·416	35·904	40·392	44·880	20
45	4·501	9·002	13·503	18·004	22·505	27·006	31·507	36·008	40·509	45·010	15
50	4·514	9·028	13·542	18·056	22·570	27·084	31·598	36·112	40·626	45·140	10
55	4·527	9·054	13·581	18·108	22·635	27·162	31·689	36·215	40·742	45·269	5
60	4·540	9·080	13·620	18·160	22·699	27·239	31·779	36·319	40·859	45·399	63° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

63 Deg. Latitudes, or Horizontal Distances for Difference of Levels

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

27°	Cosines	
27° 0′	·89101	60′
1	·89087	59
2	·89074	58
3	·89061	57
4	·89048	56
5	·89034	55
6	·89021	54
7	·89008	53
8	·88995	52
9	·88981	51
10	·88968	50
11	·88955	49
12	·88942	48
13	·88928	47
14	·88915	46
15	·88902	45
16	·88888	44
17	·88875	43
18	·88862	42
19	·88848	41
20	·88835	40
21	·88822	39
22	·88808	38
23	·88795	37
24	·88781	36
25	·88768	35
26	·88755	34
27	·88741	33
28	·88728	32
29	·88714	31
30	·88701	30
31	·88688	29
32	·88674	28
33	·88661	27
34	·88647	26
35	·88634	25
36	·88620	24
37	·88607	23
38	·88593	22
39	·88580	21
40	·88566	20
41	·88553	19
42	·88539	18
43	·88526	17
44	·88512	16
45	·88499	15
46	·88485	14
47	·88472	13
48	·88458	12
49	·88444	11
50	·88431	10
51	·88417	9
52	·88404	8
53	·88390	7
54	·88377	6
55	·88363	5
56	·88349	4
57	·88336	3
58	·88322	2
59	·88308	1
60	·88295	0 ·62
	Sines	

Departures, or Difference of Levels

27 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
27° 0′	8·910	17·820	26·730	35·640	44·550	53·461	62·371	71·281	80·191	89·101	60′
5	8·903	17·807	26·710	35·614	44·517	53·420	62·324	71·227	80·131	89·034	55
10	8·897	17·794	26·690	35·587	44·484	53·381	62·278	71·174	80·071	88·963	50
15	8·890	17·780	26·670	35·561	44·451	53·341	62·231	71·122	80·012	88·902	45
20	8·883	17·767	26·650	35·534	44·417	53·301	62·184	71·068	79·951	88·835	40
25	8·877	17·754	26·630	35·507	44·384	53·261	62·138	71·014	79·891	88·768	35
30	8·870	17·740	26·610	35·480	44·350	53·221	62·091	70·961	79·831	88·701	30
35	8·863	17·727	26·590	35·454	44·317	53·180	62·043	70·907	79·771	88·634	25
40	8·857	17·713	26·570	35·427	44·283	53·140	61·996	70·853	79·710	88·566	20
45	8·850	17·700	26·550	35·400	44·249	53·099	61·949	70·799	79·649	88·499	15
50	8·843	17·686	26·529	35·372	44·215	53·059	61·902	70·745	79·588	83·431	10
55	8·836	17·673	26·509	35·345	44·181	53·018	61·854	70·690	79·527	88·363	5
60	8·829	17·659	26·488	35·318	44·147	52·977	61·806	70·636	79·465	88·295	62° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

62 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
27° 0′	·45399	60′
1	·45425	59
2	·45451	58
3	·45477	57
4	·45503	56
5	·45528	55
6	·45554	54
7	·45580	53
8	·45606	52
9	·45632	51
10	·45658	50
11	·45684	49
12	·45710	48
13	·45736	47
14	·45761	46
15	·45787	45
16	·45813	44
17	·45839	43
18	·45865	42
19	·45891	41
20	·45917	40
21	·45942	39
22	·45968	38
23	·45994	37
24	·46020	36
25	·46046	35
26	·46072	34
27	·46097	33
28	·46123	32
29	·46149	31
30	·46175	30
31	·46201	29
32	·46226	28
33	·46252	27
34	·46278	26
35	·46304	25
36	·46330	24
37	·46355	23
38	·46381	22
39	·46407	21
40	·46433	20
41	·46458	19
42	·46484	18
43	·46510	17
44	·46536	16
45	·46561	15
46	·46587	14
47	·466 3	13
48	·46639	12
49	·46664	11
50	·46690	10
51	·46716	9
52	·46742	8
53	·46767	7
54	·46793	6
55	·46819	5
56	·46844	4
57	·46870	3
58	·46896	2
59	·46921	1
60	·46947	0 62
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

27 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
27° 0′	4·540	9·080	13·620	18·160	22·699	27·239	31·779	36·319	40·859	45·399	60′
5	4·553	9·106	13·659	18·211	22·764	27·317	31·870	36·423	40·976	45·529	55
10	4·566	9·132	13·697	18·263	22·829	27·395	31·961	36·526	41·092	45·658	50
15	4·579	9·157	13·736	18·315	22·894	27·472	32·051	36·630	41·209	45·787	45
20	4·592	9·183	13·775	18·367	22·958	27·550	32·142	36·733	41·325	45·917	40
25	4·605	9·209	13·814	18·418	23·023	27·627	32·232	36·837	41·441	46·046	35
30	4·617	9·235	13·852	18·470	23·087	27·705	32·322	36·940	41·557	46·175	30
35	4·630	9·261	13·891	18·521	23·152	27·782	32·413	37·043	41·673	46·304	25
40	4·643	9·286	13·930	18·573	23·216	27·860	32·503	37·146	41·789	46·433	20
45	4·656	9·312	13·968	18·625	23·281	27·937	32·593	37·249	41·905	46·561	15
50	4·669	9·338	14·007	18·676	23·345	28·014	32·683	37·352	42·021	46·690	10
55	4·682	9·364	14·046	18·727	23·409	28·091	32·773	37·455	42·137	46·819	5
60	4·695	9·389	14·084	18·779	23·473	28·168	32·863	37·558	42·252	46·947	62° 0
	10	20	30	40	50	60	70	80	90	100	

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

62 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
28° 0′	·88295	60′
1	·88281	59
2	·88267	58
3	·88254	57
4	·88240	56
5	·88226	55
6	·88213	54
7	·88199	53
8	·88185	52
9	·88171	51
10	·88158	50
11	·88144	49
12	·88130	48
13	·88117	47
14	·88103	46
15	·88089	45
16	·88075	44
17	·88061	43
18	·88048	42
19	·88034	41
20	·88020	40
21	·88006	39
22	·87992	38
23	·87979	37
24	·87965	36
25	·87951	35
26	·87937	34
27	·87923	33
28	·87909	32
29	·87896	31
30	·87882	30
31	·87868	29
32	·87854	28
33	·87840	27
34	·87826	26
35	·87812	25
36	·87798	24
37	·87784	23
38	·87770	22
39	·87756	21
40	·87742	20
41	·87729	19
42	·87715	18
43	·87701	17
44	·87687	16
45	·87673	15
46	·87659	14
47	·87645	13
48	·87631	12
49	·87617	11
50	·87603	10
51	·87589	9
52	·87575	8
53	·87560	7
54	·87546	6
55	·87532	5
56	·87518	4
57	·87504	3
58	·87490	2
59	·87476	1
60	·87462	0°61
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

28 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
28° 0′	8·829	17·659	26·488	35·318	44·147	52·977	61·806	70·636	79·465	88·295	60′
5	8·823	17·645	26·468	35·290	44·113	52·936	61·758	70·581	79·403	88·226	55
10	8·816	17·632	26·447	35·263	44·079	52·895	61·710	70·526	79·342	88·158	50
15	8·809	17·618	26·427	35·236	44·044	52·853	61·662	70·471	79·280	88·089	45
20	8·802	17·604	26·406	35·208	44·010	52·812	61·614	70·416	79·218	88·020	40
25	8·795	17·590	26·385	35·180	43·975	52·770	61·565	70·361	79·156	87·951	35
30	8·788	17·576	26·364	35·153	43·941	52·729	61·517	70·306	79·094	87·882	30
35	8·781	17·562	26·344	35·125	43·906	52·687	61·468	70·250	79·031	87·812	25
40	8·774	17·548	26·323	35·097	43·871	52·645	61·419	70·194	78·968	87·742	20
45	8·767	17·535	26·302	35·069	43·836	52·604	61·371	70·138	78·906	87·673	15
50	8·760	17·521	26·281	35·041	43·801	52·562	61·322	70·082	78·843	87·603	10
55	8·753	17·506	26·260	35·013	43·766	52·519	61·272	70·026	78·779	87·532	5
60	8·746	17·492	26·239	34·985	43·731	52·477	61·223	69·969	78·716	87·462	61° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

61 Deg. Departures, or Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

Departures, or Difference of Levels

	Sines	
28° 0′	·46947	60′
1	·46973	59
2	·46998	58
3	·47024	57
4	·47050	56
5	·47075	55
6	·47101	54
7	·47127	53
8	·47152	52
9	·47178	51
10	·47204	50
11	·47229	49
12	·47255	48
13	·47281	47
14	·47306	46
15	·47332	45
16	·47358	44
17	·47383	43
18	·47409	42
19	·47434	41
20	·47460	40
21	·47486	39
22	·47511	38
23	·47537	37
24	·47562	36
25	·47588	35
26	·47614	34
27	·47639	33
28	·47665	32
29	·47690	31
30	·47716	30
31	·47741	29
32	·47767	28
33	·47792	27
34	·47818	26
35	·47844	25
36	·47869	24
37	·47895	23
38	·47920	22
39	·47946	21
40	·47971	20
41	·47997	19
42	·48022	18
43	·48048	17
44	·48073	16
45	·48099	15
46	·48124	14
47	·48150	13
48	·48175	12
49	·48201	11
50	·48226	10
51	·48251	9
52	·48277	8
53	·48303	7
54	·48328	6
55	·48354	5
56	·48379	4
57	·48405	3
58	·48430	2
59	·48455	1
60	·48481	0 ·61
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

28 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
28° 0′	4·695	9·389	14·084	18·779	23·473	28·168	32·863	37·558	42·252	46·947	60′
5	4·708	9·415	14·123	18·830	23·538	28·245	32·953	37·660	42·368	47·075	55
10	4·720	9·441	14·161	18·881	23·602	28·322	33·043	37·763	42·483	47·204	50
15	4·733	9·466	14·200	18·933	23·666	28·399	33·132	37·866	42·599	47·332	45
20	4·746	9·492	14·238	18·984	23·730	28·476	33·222	37·968	42·714	47·460	40
25	4·759	9·518	14·276	19·035	23·794	28·553	33·312	38·070	42·829	47·588	35
30	4·772	9·543	14·315	19·086	23·858	28·629	33·401	38·173	42·944	47·716	30
35	4·784	9·569	14·353	19·137	23·922	28·706	33·490	38·275	43·059	47·844	25
40	4·797	9·594	14·391	19·188	23·986	28·783	33·580	38·377	43·174	47·971	20
45	4·810	9·620	14·430	19·240	24·049	28·859	33·669	38·479	43·289	48·100	15
50	4·823	9·645	14·468	19·290	24·113	28·936	33·758	38·581	43·404	48·226	10
55	4·835	9·671	14·506	19·341	24·177	29·012	33·848	38·683	43·518	48·354	5
60	4·848	9·696	14·544	19·392	24·240	29·089	33·937	38·785	43·633	48·481	61° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

61 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
29° 0′	·87462	60′
1	·87448	59
2	·87434	58
3	·87420	57
4	·87405	56
5	·87391	55
6	·87377	54
7	·87363	53
8	·87349	52
9	·87335	51
10	·87321	50
11	·87306	49
12	·87292	48
13	·87278	47
14	·87264	46
15	·87250	45
16	·87235	44
17	·87221	43
18	·87207	42
19	·87193	41
20	·87178	40
21	·87164	39
22	·87150	38
23	·87136	37
24	·87121	36
25	·87107	35
26	·87093	34
27	·87078	33
28	·87064	32
29	·87050	31
30	·87036	30
31	·87021	29
32	·87007	28
33	·86993	27
34	·86978	26
35	·86964	25
36	·86949	24
37	·86935	23
38	·86921	22
39	·86906	21
40	·86892	20
41	·86877	19
42	·86863	18
43	·86849	17
44	·86834	16
45	·86820	15
46	·86805	14
47	·86791	13
48	·86777	12
49	·86762	11
50	·86748	10
51	·86733	9
52	·86719	8
53	·86704	7
54	·86690	6
55	·86675	5
56	·86661	4
57	·86646	3
58	·86632	2
59	·86617	1
60	·86602	0·60
	Sines	

Departures, or Difference of Levels

29 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
29° 0′	8·746	17·492	26·239	34·985	43·731	52·477	61·223	69·969	78·716	87·462	60′
5	8·739	17·478	26·217	34·956	43·695	52·434	61·174	69·913	78·652	87·391	55
10	8·732	17·464	26·196	34·928	43·660	52·392	61·124	69·856	78·588	87·320	50
15	8·725	17·450	26·175	34·900	43·625	52·350	61·075	69·800	78·525	87·250	45
20	8·718	17·436	26·153	34·871	43·589	52·307	61·025	69·742	78·460	87·178	40
25	8·711	17·421	26·132	34·843	43·553	52·264	60·975	69·686	78·396	87·107	35
30	8·703	17·407	26·110	34·814	43·517	52·221	60·924	69·628	78·331	87·035	30
35	8·696	17·393	26·089	34·785	43·481	52·178	60·874	69·570	78·267	86·963	25
40	8·689	17·378	26·068	34·757	43·446	52·135	60·824	69·514	78·203	86·892	20
45	8·682	17·364	26·046	34·728	43·410	52·092	60·774	69·456	78·138	86·820	15
50	8·675	17·350	26·024	34·699	43·374	52·049	60·724	69·398	78·073	86·748	10
55	8·667	17·335	26·002	34·670	43·337	52·005	60·672	69·340	78·007	86·675	5
60	8·660	17·320	25·981	34·641	43·301	51·961	60·621	69·282	77·942	86·602	60° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

60 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
29° 0′	·48481	60′
1	·48506	59
2	·48532	58
3	·48557	57
4	·48583	56
5	·48608	55
6	·48633	54
7	·48659	53
8	·48684	52
9	·48710	51
10	·48735	50
11	·48761	49
12	·48786	48
13	·48811	47
14	·48837	46
15	·48862	45
16	·48887	44
17	·48913	43
18	·48938	42
19	·48964	41
20	·48989	40
21	·49014	39
22	·49040	38
23	·49065	37
24	·49090	36
25	·49116	35
26	·49141	34
27	·49166	33
28	·49192	32
29	·49217	31
30	·49242	30
31	·49268	29
32	·49293	28
33	·49318	27
34	·49344	26
35	·49369	25
36	·49394	24
37	·49419	23
38	·49445	22
39	·49470	21
40	·49495	20
41	·49521	19
42	·49546	18
43	·49571	17
44	·49596	16
45	·49622	15
46	·49647	14
47	·49672	13
48	·49697	12
49	·49723	11
50	·49748	10
51	·49773	9
52	·49798	8
53	·49823	7
54	·49849	6
55	·49874	5
56	·49899	4
57	·49924	3
58	·49950	2
59	·49975	1
60	·50000	0′ 60°
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

29 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
29° 0′	4·848	9·696	14·544	19·392	24·240	29·089	33·937	38·785	43·633	48·481	60′
5	4·861	9·722	14·582	19·443	24·304	29·165	34·026	38·886	43·747	48·608	55
10	4·874	9·747	14·620	19·494	24·368	29·241	34·115	38·988	43·861	48·735	50
15	4·886	9·772	14·659	19·545	24·431	29·317	34·203	39·090	43·976	48·862	45
20	4·899	9·798	14·697	19·596	24·494	29·393	34·292	39·191	44·090	48·989	40
25	4·912	9·823	14·735	19·646	24·558	29·469	34·381	39·293	44·204	49·116	35
30	4·924	9·848	14·773	19·697	24·621	29·545	34·470	39·394	44·318	49·242	30
35	4·937	9·874	14·811	19·748	24·684	29·621	34·558	39·495	44·432	49·369	25
40	4·950	9·899	14·849	19·798	24·748	29·697	34·647	39·596	44·546	49·495	20
45	4·962	9·924	14·886	19·849	24·811	29·773	34·735	39·697	44·659	49·622	15
50	4·975	9·950	14·924	19·899	24·874	29·849	34·823	39·798	44·773	49·748	10
55	4·987	9·975	14·962	19·950	24·937	29·924	34·912	39·899	44·887	49·874	5
60	5·000	10·000	15·000	20·000	25·000	30·000	35·000	40·000	45·000	50·000	60° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

60 Deg. Latitudes, or Horizontal Distances for Difference of Levels

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
30° 0′	·86602	60′
1	·86588	59
2	·86573	58
3	·86559	57
4	·86544	56
5	·86530	55
6	·86515	54
7	·86501	53
8	·86486	52
9	·86471	51
10	·86457	50
11	·86442	49
12	·86427	48
13	·86413	47
14	·86398	46
15	·86384	45
16	·86369	44
17	·86354	43
18	·86340	42
19	·86325	41
20	·86310	40
21	·86295	39
22	·86281	38
23	·86266	37
24	·86251	36
25	·86237	35
26	·86222	34
27	·86207	33
28	·86192	32
29	·86178	31
30	·86163	30
31	·86148	29
32	·86133	28
33	·86119	27
34	·86104	26
35	·86089	25
36	·86074	24
37	·86059	23
38	·86045	22
39	·86030	21
40	·86015	20
41	·86000	19
42	·85985	18
43	·85970	17
44	·85955	16
45	·85941	15
46	·85926	14
47	·85911	13
48	·85896	12
49	·85881	11
50	·85866	10
51	·85851	9
52	·85836	8
53	·85821	7
54	·85806	6
55	·85791	5
56	·85777	4
57	·85762	3
58	·85747	2
59	·85732	1
60	·85717	0° 59
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

30 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
30° 0′	8·660	17·320	25·981	34·641	43·301	51·961	60·621	69·282	77·942	86·602	60′
5	8·653	17·306	25·959	34·612	43·265	51·918	60·571	69·224	77·877	86·530	55
10	8·646	17·291	25·937	34·583	43·228	51·874	60·520	69·166	77·811	86·457	50
15	8·638	17·276	25·915	34·553	43·191	51·830	60·468	69 106	77·745	86·383	45
20	8·631	17·262	25·893	34·524	43·155	51·786	60·417	69·048	77·679	86·310	40
25	8·624	17·247	25·871	34·495	43·118	51·742	60·366	68·990	77·613	86·237	35
30	8·616	17·233	25·849	34·465	43·081	51·698	60·314	68·930	77·547	86·163	30
35	8·609	17·218	25·827	34·436	43·044	51·653	60·262	68·871	77·480	86·089	25
40	8·601	17·203	25·804	34·406	43·007	51·609	60·210	68·812	77·413	86·015	20
45	8·594	17·188	25·782	34·376	42·970	51·565	60·159	68·753	77·347	85·941	15
50	8·587	17·173	25·760	34·346	42·933	51·520	60·106	68·693	77·279	85·866	10
55	8·579	17·158	25·737	34·316	42·895	51·475	60·054	68·633	77·212	85·791	5
60	8·572	17·143	25·715	34·287	42·858	51·430	60·002	68·574	77·145	85·717	59° 0
	10	20	30	40	50	60	70	80	90	100	

DEPARTURES, OR DIFFERENCE OF LEVELS

59 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
30° 0'	·50000	60'
1	·50025	59
2	·50050	58
3	·50076	57
4	·50100	56
5	·50126	55
6	·50151	54
7	·50176	53
8	·50201	52
9	·50226	51
10	·50252	50
11	·50277	49
12	·50302	48
13	·50327	47
14	·50352	46
15	·50377	45
16	·50402	44
17	·50428	43
18	·50453	42
19	·50478	41
20	·50503	40
21	·50528	39
22	·50553	38
23	·50578	37
24	·50603	36
25	·50628	35
26	·50653	34
27	·50679	33
28	·50704	32
29	·50729	31
30	·50754	30
31	·50779	29
32	·50804	28
33	·50829	27
34	·50854	26
35	·50879	25
36	·50904	24
37	·50929	23
38	·50954	22
39	·50979	21
40	·51004	20
41	·51029	19
42	·51054	18
43	·51079	17
44	·51104	16
45	·51129	15
46	·51154	14
47	·51179	13
48	·51204	12
49	·51229	11
50	·51254	10
51	·51279	9
52	·51304	8
53	·51329	7
54	·51354	6
55	·51379	5
56	·51404	4
57	·51429	3
58	·51454	2
59	·51479	1
60	·51504	0' 59
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

30 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
30° 0'	5·000	10·000	15·000	20·000	25·000	30·000	35·000	40·000	45·000	50·000	60'
5	5·013	10·025	15·038	20·050	25·063	30·075	35·088	40·101	45·113	50·126	55
10	5·025	10·050	15·075	20·101	25·126	30·151	35·176	40·201	45·226	50·252	50
15	5·038	10·075	15·113	20·151	25·189	30·226	35·264	40·302	45·340	50·377	45
20	5·050	10·101	15·151	20·201	25·251	30·302	35·352	40·402	45·453	50·503	40
25	5·063	10·126	15·188	20·251	25·314	30·377	35·440	40·503	45·565	50·628	35
30	5·075	10·151	15·226	20·301	25·378	30·452	35·528	40·603	45·678	50·754	30
35	5·088	10·176	15·264	20·352	25·439	30·527	35·615	40·703	45·791	50·879	25
40	5·100	10·201	15·301	20·402	25·502	30·603	35·703	40·803	45·904	51·004	20
45	5·113	10·226	15·339	20·452	25·565	30·678	35·790	40·903	46·016	51·129	15
50	5·125	10·251	15·376	20·502	25·627	30·752	35·878	41·003	46·129	51·254	10
55	5·138	10·276	15·414	20·552	25·689	30·827	35·965	41·103	46·241	51·379	5
60	5·150	10·301	15·451	20·601	25·752	30·902	36·053	41·203	46·353	51·504	59° 0
	10	20	30	40	50	60	70	80	90	100	

59 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
31° 0'	·85717	60'
1	·85702	59
2	·85687	58
3	·85672	57
4	·85657	56
5	·85642	55
6	·85627	54
7	·85612	53
8	·85597	52
9	·85582	51
10	·85567	50
11	·85551	49
12	·85536	48
13	·85521	47
14	·85506	46
15	·85491	45
16	·85476	44
17	·85461	43
18	·85446	42
19	·85431	41
20	·85416	40
21	·85400	39
22	·85385	38
23	·85370	37
24	·85355	36
25	·85340	35
26	·85325	34
27	·85310	33
28	·85294	32
29	·85279	31
30	·85264	30
31	·85249	29
32	·85234	28
33	·85218	27
34	·85203	26
35	·85188	25
36	·85173	24
37	·85157	23
38	·85142	22
39	·85127	21
40	·85112	20
41	·85096	19
42	·85081	18
43	·85066	17
44	·85050	16
45	·85035	15
46	·85020	14
47	·85005	13
48	·84989	12
49	·84974	11
50	·84959	10
51	·84943	9
52	·84928	8
53	·84912	7
54	·84897	6
55	·84882	5
56	·84866	4
57	·84851	3
58	·84836	2
59	·84820	1
60	·84805	0' 58
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

31 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
31° 0'	8·572	17·143	25·715	34·287	42·858	51·430	60·002	68·574	77·145	85·717	60'
5	8·564	17·128	25·693	34·257	42·821	51·385	59·949	68·514	77·078	85·642	55
10	8·557	17·113	25·670	34·226	42·783	51·340	59·896	68·453	77·009	85·566	50
15	8·549	17·098	25·647	34·196	42·745	51·295	59·844	68·393	76·942	85·491	45
20	8·541	17·083	25·624	34·166	42·707	51·249	59·790	68·332	76·873	85·415	40
25	8·534	17·068	25·602	34·136	42·670	51·204	59·738	68·272	76·806	85·340	35
30	8·526	17·053	25·579	34·106	42·632	51·158	59·685	68·211	76·738	85·264	30
35	8·519	17·038	25·556	34·075	42·594	51·113	59·632	68·150	76·669	85·188	25
40	8·511	17·022	25·534	34·045	42·556	51·067	59·578	68·090	76·601	85·112	20
45	8·503	17·007	25·510	34·014	42·517	51·021	59·524	68·028	76·531	85·035	15
50	8·496	16·992	25·488	33·984	42·479	50·975	59·471	67·967	76·463	84·959	10
55	8·488	16·976	25·465	33·953	42·441	50·929	59·417	67·906	76·394	84·882	5
60	8·480	16·961	25·441	33·922	42·402	50·883	59·363	67·844	76·324	84·805	58° 0
	10	20	30	40	50	60	70	80	90	100	

DEPARTURES, OR DIFFERENCE OF LEVELS

58 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
31° 0	·51504	60′
1	·51529	59
2	·51554	58
3	·51579	57
4	·51603	56
5	·51628	55
6	·51653	54
7	·51678	53
8	·51703	52
9	·51728	51
10	·51753	50
11	·51778	49
12	·51803	48
13	·51828	47
14	·51852	46
15	·51877	45
16	·51902	44
17	·51927	43
18	·51952	42
19	·51977	41
20	·52002	40
21	·52026	39
22	·52051	38
23	·52076	37
24	·52101	36
25	·52126	35
26	·52151	34
27	·52175	33
28	·52200	32
29	·52225	31
30	·52250	30
31	·52275	29
32	·52299	28
33	·52324	27
34	·52349	26
35	·52374	25
36	·52399	24
37	·52423	23
38	·52448	22
39	·52473	21
40	·52498	20
41	·52522	19
42	·52547	18
43	·52572	17
44	·52597	16
45	·52621	15
46	·52646	14
47	·52671	13
48	·52696	12
49	·52720	11
50	·52745	10
51	·52770	9
52	·52794	8
53	·52819	7
54	·52844	6
55	·52868	5
56	·52893	4
57	·52918	3
58	·52943	2
59	·52967	1
60	·52992	0′ 58
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

31 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
31° 0′	5·150	10·301	15·451	20·601	25·752	30·902	36·053	41·203	46·353	51·500	60′
5	5·163	10·326	15·488	20·651	25·814	30·977	36·140	41·303	46·466	51·628	55
10	5·175	10·350	15·526	20·701	25·876	31·052	36·227	41·402	46·578	51·753	50
15	5·188	10·375	15·563	20·751	25·939	31·126	36·314	41·502	46·690	51·877	45
20	5·200	10·400	15·600	20·801	26·001	31·201	36·401	41·601	46·801	52·002	40
25	5·213	10·425	15·638	20·850	26·063	31·275	36·488	41·701	46·913	52·126	35
30	5·225	10·450	15·675	20·900	26·125	31·350	36·575	41·800	47·025	52·250	30
35	5·237	10·475	15·712	20·950	26·187	31·424	36·662	41·899	47·136	52·374	25
40	5·250	10·500	15·749	20·999	26·249	31·499	36·748	41·998	47·248	52·498	20
45	5·262	10·524	15·786	21·049	26·311	31·573	36·835	42·097	47·359	52·621	15
50	5·274	10·549	15·823	21·098	26·372	31·647	36·921	42·196	47·470	52·745	10
55	5·287	10·574	15·861	21·147	26·434	31·721	37·008	42·295	47·582	52·868	5
60	5·299	10·598	15·898	21·197	26·496	31·795	37·094	42·393	47·693	52·992	58° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

58 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
32° 0'	·84805	60'
1	·84789	59
2	·84774	58
3	·84758	57
4	·84743	56
5	·84728	55
6	·84712	54
7	·84697	53
8	·84681	52
9	·84666	51
10	·84650	50
11	·84635	49
12	·84619	48
13	·84604	47
14	·84588	46
15	·84573	45
16	·84557	44
17	·84542	43
18	·84526	42
19	·84511	41
20	·84495	40
21	·84479	39
22	·84464	38
23	·84448	37
24	·84433	36
25	·84417	35
26	·84402	34
27	·84386	33
28	·84370	32
29	·84355	31
30	·84339	30
31	·84323	29
32	·84308	28
33	·84292	27
34	·84277	26
35	·84261	25
36	·84245	24
37	·84230	23
38	·84214	22
39	·84198	21
40	·84182	20
41	·84167	19
42	·84151	18
43	·84135	17
44	·84119	16
45	·84104	15
46	·84088	14
47	·84072	13
48	·84057	12
49	·84041	11
50	·84025	10
51	·84009	9
52	·83994	8
53	·83978	7
54	·83962	6
55	·83946	5
56	·83930	4
57	·83915	3
58	·83898	2
59	·83882	1
60	·83867	0° 57
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

32 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
32° 0'	8·480	16·961	25·441	33·922	42·402	50·883	59·363	67·844	76·324	84·805	60'
5	8·473	16·945	25·418	33·891	42·364	50·837	59·310	67·782	76·255	84·736	55
10	8·465	16·930	25·395	33·860	42·325	50·790	59·255	67·720	76·185	84·660	50
15	8·457	16·915	25·372	33·829	42·286	50·744	59·201	67·658	76·116	84·573	45
20	8·449	16·899	25·348	33·798	42·247	50·696	59·146	67·595	76·045	84·494	40
25	8·442	16·883	25·325	33·767	42·208	50·650	59·092	67·534	75·975	84·417	35
30	8·434	16·868	25·302	33·736	42·169	50·603	59·037	67·471	75·905	84·339	30
35	8·426	16·852	25·278	33·704	42·130	50·557	58·983	67·409	75·835	84·261	25
40	8·418	16·836	25·254	33·673	42·091	50·509	58·927	67·345	75·764	84·182	20
45	8·410	16·821	25·231	33·642	42·052	50·462	58·873	67·283	75·694	84·104	15
50	8·402	16·805	25·207	33·610	42·012	50·415	58·817	67·220	75·622	84·025	10
55	8·395	16·789	25·183	33·578	41·973	50·368	58·762	67·157	75·551	83·946	5
60	8·387	16·773	25·160	33·547	41·933	50·320	58·707	67·094	75·480	83·867	57° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

57 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
32° 0′	·52992	60′
1	·53017	59
2	·53041	58
3	·53066	57
4	·53091	56
5	·53115	55
6	·53140	54
7	·53164	53
8	·53189	52
9	·53214	51
10	·53238	50
11	··3263	49
12	·53288	48
13	·53312	47
14	·53337	46
15	·53361	45
16	·53386	44
17	·53411	43
18	·53435	42
19	·53460	41
20	·53484	40
21	·53509	39
22	·53533	38
23	·53558	37
24	·53583	36
25	·53607	35
26	·53632	34
27	·53656	33
28	·53681	32
29	·53705	31
30	·53730	30
31	·53754	29
32	·53779	28
33	·53803	27
34	·53828	26
35	·53853	25
36	·53877	24
37	·53902	23
38	·53926	22
39	·53951	21
40	·53975	20
41	·53999	19
42	·54024	18
43	·54048	17
44	·54073	16
45	·54097	15
46	·54122	14
47	·54146	13
48	·54171	12
49	·54195	11
50	·54220	10
51	·54244	9
52	·54269	8
53	·54293	7
54	·54317	6
55	·54342	5
56	·54366	4
57	·54391	3
58	·54415	2
59	·54439	1
60	·54464	0° 57
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

32 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
32° 0′	5·299	10·598	15·898	21·197	26·496	31·795	37·094	42·393	47·693	52·992	60′
5	5·311	10·623	15·934	21·246	26·558	31·869	37·181	42·492	47·804	53·115	55
10	5·324	10·648	15·971	21·295	26·619	31·943	37·267	42·591	47·915	53·238	50
15	5·336	10·672	16·008	21·345	26·681	32·017	37·353	42·689	48·025	53·361	45
20	5·348	10·697	16·045	21·394	26·742	32·091	37·439	42·787	48·136	53·484	40
25	5·361	10·721	16·082	21·443	26·804	32·164	37·525	42·886	48·246	53·607	35
30	5·373	10·746	16·119	21·492	26·865	32·238	37·611	42·984	48·357	53·730	30
35	5·385	10·770	16·156	21·541	26·926	32·311	37·697	43·082	48·467	53·853	25
40	5·398	10·795	16·192	21·590	26 987	32·385	37·782	43·180	48·578	53·975	20
45	5·410	10·819	16·229	21·639	27·049	32·458	37·868	43·278	48·688	54·097	15
50	5·422	10·844	16·266	21·688	27·110	32·532	37·954	43·376	48·798	54·220	10
55	5·434	10·868	16·303	21·737	27·171	32·605	38·039	43·473	48·908	54·342	5
60	5·446	10·893	16·339	21·786	27·232	32·678	38·125	43·571	49·017	54·464	57° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

57 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels	Cosines	
33° 0′	·83867	60′
1	·83851	59
2	·83835	58
3	·83819	57
4	·83804	56
5	·83788	55
6	·83772	54
7	·83756	53
8	·83740	52
9	·83724	51
10	·83708	50
11	·83692	49
12	·83676	48
13	·83660	47
14	·83645	46
15	·83629	45
16	·83613	44
17	·83597	43
18	·83581	42
19	·83565	41
20	·83549	40
21	·83533	39
22	·83517	38
23	·83501	37
24	·83485	36
25	·83469	35
26	·83453	34
27	·83437	33
28	·83421	32
29	·83405	31
30	·83389	30
31	·83372	29
32	·83356	28
33	·83340	27
34	·83324	26
35	·83308	25
36	·83292	24
37	·83276	23
38	·83260	22
39	·83244	21
40	·83228	20
41	·83211	19
42	·83195	18
43	·83179	17
44	·83163	16
45	·83147	15
46	·83131	14
47	·83114	13
48	·83098	12
49	·83082	11
50	·83066	10
51	·83050	9
52	·83034	8
53	·83017	7
54	·83001	6
55	·82985	5
56	·82969	4
57	·82952	3
58	·82936	2
59	·82920	1
60	·82904	0 56°
	Sines	
Departures, or Difference of Levels		

33 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
33° 0′	8·387	16·773	25·160	33·547	41·933	50·320	58·707	67·094	75·480	83·867	60′
5	8·379	16·758	25·138	33·517	41·896	50·275	58·654	67·032	75·411	83·790	55
10	8·371	16·742	25·112	33·483	41·854	50·225	58·596	66·966	75·337	83·708	50
15	8·363	16·726	25·089	33·452	41·814	50·177	58·540	66·903	75·266	83·629	45
20	8·355	16·710	25·065	33·420	41·774	50·129	58·484	66·839	75·194	83·549	40
25	8·347	16·694	25·041	33·388	41·734	50·081	58·428	66·775	75·122	83·469	35
30	8·339	16·678	25·016	33·355	41·694	50·033	58·372	66·710	75·049	83·388	30
35	8·331	16·662	24·992	33·323	41·654	49·985	58·316	66·646	74·977	83·308	25
40	8·323	16·646	24·968	33·291	41·614	49·937	58·260	66·582	74·905	83·228	20
45	8·315	16·629	24·944	33·260	41·573	49·888	58·203	66·518	74·832	83·147	15
50	8·307	16·613	24·920	33·226	41·533	49·839	58·146	66·453	74·759	83·066	10
55	8·298	16·597	24·895	33·194	41·492	49·791	58·089	66·388	74·686	82·985	5
60	8·290	16·581	24·871	33·162	41·452	49·742	58·033	66·323	74·614	82·904	56° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

56 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
33° 0'	·54464	60'
1	·54488	59
2	·54513	58
3	·54537	57
4	·54561	56
5	·54586	55
6	·54610	54
7	·54635	53
8	·54659	52
9	·54683	51
10	·54708	50
11	·54732	49
12	·54756	48
13	·54781	47
14	·54805	46
15	·54829	45
16	·54854	44
17	·54878	43
18	·54902	42
19	·54927	41
20	·54951	40
21	·54975	39
22	·54999	38
23	·55024	37
24	·55048	36
25	·55072	35
26	·55097	34
27	·55121	33
28	·55145	32
29	·55169	31
30	·55194	30
31	·55218	29
32	·55242	28
33	·55266	27
34	·55291	26
35	·55315	25
36	·55339	24
37	·55363	23
38	·55388	22
39	·55412	21
40	·55436	20
41	·55460	19
42	·55484	18
43	·55509	17
44	·55533	16
45	·55557	15
46	·55581	14
47	·55605	13
48	·55630	12
49	·55654	11
50	·55678	10
51	·55702	9
52	·55726	8
53	·55750	7
54	·55774	6
55	·55799	5
56	·55823	4
57	·55847	3
58	·55871	2
59	·55895	1
60	·55919	0 56°
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

33 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
33° 0'	5·446	10·893	16·339	21·786	27·232	32·678	38·125	43·571	49·017	54·464	60'
5	5·459	10·917	16·376	21·834	27·293	32·751	38·210	43·669	49·127	54·586	55
10	5·471	10·941	16·412	21·883	27·354	32·825	38·295	43·766	49·237	54·708	50
15	5·483	10·966	16·449	21·932	27·415	32·898	38·380	43·863	49·346	54·829	45
20	5·495	10·990	16·485	21·980	27·475	32·970	38·466	43·961	49·456	54·951	40
25	5·507	11·014	16·522	22·029	27·536	33·043	38·551	44·058	49·565	55·072	35
30	5·519	11·039	16·558	22·077	27·597	33·116	38·636	44·155	49·674	55·194	30
35	5·531	11·063	16·594	22·126	27·657	33·189	38·720	44·252	49·783	55·315	25
40	5·544	11·087	16·631	22·174	27·718	33·262	38·805	44·349	49·892	55·436	20
45	5·556	11·111	16·667	22·223	27·778	33·334	38·890	44·446	50·001	55·557	15
50	5·568	11·136	16·703	22·271	27·839	33·407	38·974	44·542	50·110	55·678	10
55	5·580	11·160	16·740	22·319	27·899	33·479	39·059	44·639	50·219	55·799	5
60	5·592	11·184	16·776	22·368	27·960	33·552	39·143	44·735	50·327	55·919	56° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

56 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
34° 0'	·82904	60'
1	·82887	59
2	·82871	58
3	·82855	57
4	·82839	56
5	·82822	55
6	·82806	54
7	·82790	53
8	·82773	52
9	·82757	51
10	·82741	50
11	·82724	49
12	·82708	48
13	·82692	47
14	·82675	46
15	·82659	45
16	·82643	44
17	·82626	43
18	·82610	42
19	·82593	41
20	·82577	40
21	·82561	39
22	·82544	38
23	·82528	37
24	·82511	36
25	·82495	35
26	·82478	34
27	·82462	33
28	·82446	32
29	·82429	31
30	·82413	30
31	·82396	29
32	·82380	28
33	·82363	27
34	·82347	26
35	·82330	25
36	·82314	24
37	·82297	23
38	·82281	22
39	·82264	21
40	·82247	20
41	·82231	19
42	·82214	18
43	·82198	17
44	·82181	16
45	·82165	15
46	·82148	14
47	·82131	13
48	·82115	12
49	·82098	11
50	·82082	10
51	·82065	9
52	·82048	8
53	·82032	7
54	·82015	6
55	·81998	5
56	·81982	4
57	·81965	3
58	·81948	2
59	·81932	1
60	·81915	0°55
	Sines	

Departures, or Difference of Levels

34 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
34° 0'	8·290	16·581	24·871	33·162	41·452	49·742	58·033	66·323	74·614	82·904	60'
5	8·282	16·564	24·847	33·129	41·411	49·693	57·975	66·258	74·540	82·822	55
10	8·274	16·548	24·822	33·096	41·370	49·644	57·919	66·193	74·467	82·741	50
15	8·266	16·532	24·797	33·064	41·329	49·595	57·861	66·127	74·393	82·659	45
20	8·258	16·515	24·773	33·031	41·288	49·546	57·804	66·062	74·319	82·577	40
25	8·249	16·499	24·748	32·998	41·247	49·497	57·746	65·996	74·245	82·495	35
30	8·241	16·483	24·724	32·965	41·206	49·448	57·689	65·930	74·172	82·413	30
35	8·233	16·466	24·699	32·932	41·165	49·398	57·631	65·864	74·097	82·330	25
40	8·225	16·449	24·674	32·899	41·123	49·348	57·573	65·798	74·022	82·247	20
45	8·216	16·433	24·649	32·866	41·082	49·299	57·515	65·732	73·948	82·165	15
50	8·208	16·416	24·625	32·833	41·041	49·249	57·457	65·666	73·874	82·082	10
55	8·200	16·400	24·599	32·799	40·999	49·199	57·399	65·598	73·798	81·998	5
60	8·191	16·383	24·574	32·766	40·957	49·149	57·340	65·532	73·723	81·915	55° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

55 Deg. Departures, or Difference of Levels

TABLE II.

Departures, or Difference of Levels

	Sines	
34° 0′	·55919	60′
1	·55943	59
2	·55967	58
3	·55992	57
4	·56016	56
5	·56040	55
6	·56064	54
7	·56088	53
8	·56112	52
9	·56136	51
10	·56160	50
11	·56184	49
12	·56208	48
13	·56232	47
14	·56256	46
15	·56280	45
16	·56304	44
17	·56329	43
18	·56353	42
19	·56377	41
20	·56401	40
21	·56425	39
22	·56449	38
23	·56473	37
24	·56497	36
25	·56521	35
26	·56545	34
27	·56569	33
28	·56593	32
29	·56617	31
30	·56641	30
31	·56665	29
32	·56689	28
33	·56712	27
34	·56736	26
35	·56760	25
36	·56784	24
37	·56808	23
38	·56832	22
39	·56856	21
40	·56880	20
41	·56904	19
42	·56928	18
43	·56952	17
44	·56976	16
45	·57000	15
46	·57024	14
47	·57047	13
48	·57071	12
49	·57095	11
50	·57119	10
51	·57143	9
52	·57167	8
53	·57191	7
54	·57215	6
55	·57238	5
56	·57262	4
57	·57286	3
58	·57310	2
59	·57334	1
60	·57358	0°55
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

34 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
34° 0′	5·592	11·184	16·776	22·368	27·960	33·552	39·143	44·735	50·327	55·919	60′
5	5·604	11·208	16·812	22·416	28·020	33·624	39·228	44·832	50·436	56·040	55
10	5·616	11·232	16·848	22·464	28·080	33·696	39·312	44·928	50·544	56·160	50
15	5·628	11·256	16·884	22·512	28·140	33·768	39·396	45·024	50·652	56·280	45
20	5·640	11·280	16·920	22·560	28·200	33·840	39·480	45·120	50·760	56·401	40
25	5·652	11·304	16·956	22·608	28·260	33·912	39·564	45·216	50·869	56·521	35
30	5·664	11·328	16·992	22·656	28·320	33·984	39·648	45·312	50·976	56·641	30
35	5·676	11·352	17·028	22·704	28·380	34·056	39·732	45·408	51·084	56·760	25
40	5·688	11·376	17·064	22·752	28·440	34·128	39·816	45·504	51·192	56·880	20
45	5·700	11·400	17·100	22·800	28·500	34·200	39·900	45·600	51·300	57·000	15
50	5·712	11·424	17·136	22·848	28·560	34·271	39·983	45·695	51·407	57·119	10
55	5·724	11·448	17·171	22·895	28·619	34·343	40·068	45·791	51·515	57·238	5
60	5·736	11·471	17·207	22·943	28·679	34·415	40·150	45·886	51·622	57·358	55° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

55 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
35° 0'	·81915	60'
1	·81898	59
2	·81882	58
3	·81865	57
4	·81848	56
5	·81832	55
6	·81815	54
7	·81798	53
8	·81781	52
9	·81765	51
10	·81748	50
11	·81731	49
12	·81714	48
13	·81698	47
14	·81681	46
15	·81664	45
16	·81647	44
17	·81631	43
18	·81614	42
19	·81597	41
20	·81580	40
21	·81563	39
22	·81546	38
23	·81530	37
24	·81513	36
25	·81496	35
26	·81479	34
27	·81462	33
28	·81445	32
29	·81428	31
30	·81412	30
31	·81395	29
32	·81378	28
33	·81361	27
34	·81344	26
35	·81327	25
36	·81310	24
37	·81293	23
38	·81276	22
39	·81259	21
40	·81242	20
41	·81225	19
42	·81208	18
43	·81191	17
44	·81174	16
45	·81157	15
46	·81140	14
47	·81123	13
48	·81106	12
49	·81089	11
50	·81072	10
51	·81055	9
52	·81038	8
53	·81021	7
54	·81004	6
55	·80987	5
56	·80970	4
57	·80953	3
58	·80936	2
59	·80918	1
60	·80902	0°54
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

35 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
35° 0'	8·191	16·383	24·574	32·766	40·957	49·149	57·340	65·532	73·723	81·915	60'
5	8·183	16·366	24·549	32·733	40·916	49·099	57·282	65·465	73·649	81·832	55
10	8·175	16·350	24·524	32·699	40·874	49·049	57·224	65·398	73·573	81·748	50
15	8·166	16·333	24·499	32·666	40·832	48·998	57·165	65·331	73·498	81·664	45
20	8·158	16·316	24·474	32·632	40·790	48·948	57·106	65·264	73·422	81·580	40
25	8·150	16·299	24·449	32·598	40·748	48·898	57·047	65·197	73·346	81·496	35
30	8·141	16·282	24·423	32·564	40·705	48·846	56·988	65·129	73·270	81·411	30
35	8·133	16·265	24·398	32·531	40·663	48·796	56·929	65·062	73·194	81·327	25
40	8·124	16·248	24·373	32·497	40·621	48·745	56·869	64·994	73·118	81·242	20
45	8·116	16·231	24·347	32·463	40·578	48·694	56·810	64·926	73·041	81·157	15
50	8·107	16·214	24·322	32·429	40·536	48·643	56·750	64·858	72·965	81·072	10
55	8·099	16·197	24·296	32·395	40·493	48·592	56·691	64·790	72·888	80·987	5
60	8·090	16·180	24·271	32·361	40·451	48·541	56·631	64·722	72·812	80·902	54° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

54 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
35° 0'	·57358	60'
1	·57381	59
2	·57405	58
3	·57429	57
4	·57453	56
5	·57477	55
6	·57500	54
7	·57524	53
8	57548	52
9	·57572	51
10	·57596	50
11	·57619	49
12	·57643	48
13	·57667	47
14	·57691	46
15	·57714	45
16	·57738	44
17	·57762	43
18	·57786	42
19	·57809	41
20	·57833	40
21	·57857	39
22	·57881	38
23	·57904	37
24	·57928	36
25	·57952	35
26	·57975	34
27	·57999	33
28	·58023	32
29	·58047	31
30	·58070	30
31	·58094	29
32	·58118	28
33	·58141	27
34	·58165	26
35	·58189	25
36	·58212	24
37	·58236	23
38	·58260	22
39	·58283	21
40	·58307	20
41	·58330	19
42	·58354	18
43	·58378	17
44	·58401	16
45	·58425	15
46	·58449	14
47	·58472	13
48	·58496	12
49	·58519	11
50	·58543	10
51	·58566	9
52	·58590	8
53	·58614	7
54	·58637	6
55	·58661	5
56	·58684	4
57	·58708	3
58	·58731	2
59	·58755	1
60	·58778	0°54
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

35 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
35° 0	5·736	11·471	17·207	22·943	28·679	34·415	40·150	45·886	51·622	57·358	60'
5	5·748	11·495	17·243	22·991	28·738	34·486	40·234	45·981	51·729	57·477	55
10	5·760	11·519	17·279	23·038	28·798	34·557	40·317	46·076	51·836	57·596	50
15	5·771	11·543	17·314	23·086	28·857	34·629	40·400	46·172	51·943	57·714	45
20	5·783	11·567	17·350	23·133	28·917	34·699	40·483	46·266	52·050	57·833	40
25	5·795	11·590	17·385	23·181	28·976	34·771	40·566	46·361	52·157	57·952	35
30	5·807	11·614	17·421	23·228	29·035	34·842	40·649	46·456	52·263	58·070	30
35	5·819	11·638	17·457	23·275	29·094	34·913	40·732	46·551	52·370	58·189	25
40	5·831	11·661	17·492	23·323	29·153	34·984	40·815	46·645	52·476	58·307	20
45	5·842	11·685	17·527	23·370	29·212	35·055	40·897	46·740	52·582	58·425	15
50	5·854	11·708	17·563	23·417	29·271	35·126	40·980	46·834	52·688	58·543	10
55	5·866	11·732	17·598	23·464	29·330	35·196	41·062	46·929	52·795	58·661	5
60	5·878	11·756	17·634	23·511	29·389	35·267	41·145	47·023	52·901	58·778	54° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

54 Deg. Latitudes, or Horizontal Distances for Difference of Levels

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
36° 0′	·80902	60′
1	·80885	59
2	·80867	58
3	·80850	57
4	·80833	56
5	·80816	55
6	·80799	54
7	·80782	53
8	·80765	52
9	·80747	51
10	·80730	50
11	·80713	49
12	·80696	48
13	·80679	47
14	·80662	46
15	·80644	45
16	·80627	44
17	·80610	43
18	·80593	42
19	·80576	41
20	·80558	40
21	·80541	39
22	·80524	38
23	·80507	37
24	·80489	36
25	·80472	35
26	·80455	34
27	·80438	33
28	·80420	32
29	·80403	31
30	·80386	30
31	·80368	29
32	·80351	28
33	·80334	27
34	·80316	26
35	·80299	25
36	·80282	24
37	·80264	23
38	·80247	22
39	·80230	21
40	·80212	20
41	·80195	19
42	·80178	18
43	·80160	17
44	·80143	16
45	·80125	15
46	·80108	14
47	·80091	13
48	·80073	12
49	·80056	11
50	·80038	10
51	·80021	9
52	·80003	8
53	·79986	7
54	·79968	6
55	·79951	5
56	·79933	4
57	·79916	3
58	·79898	2
59	·79881	1
60	·79864	0 53°
	Sines	

Departures, or Difference of Levels

36 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
36° 0′	8·090	16·180	24·271	32·361	40·451	48·541	56·631	64·722	72·812	80·902	60′
5	8·082	16·163	24·245	32·326	40·408	48·490	56·571	64·653	72·734	80·816	55
10	8·073	16·146	24·219	32·292	40·365	48·438	56·511	64·584	72·657	80·730	50
15	8·064	16·129	24·193	32·258	40·322	48·386	56·451	64·515	72·580	80·644	45
20	8·056	16·112	24·167	32·223	40·279	48·335	56·391	64·446	72·502	80·558	40
25	8·047	16·094	24·142	32·189	40·236	48·283	56·330	64·378	72·425	80·472	35
30	8·039	16·077	24·116	32·154	40·193	48·232	56·270	64·309	72·347	80·386	30
35	8·030	16·060	24·090	32·120	40·149	48·179	56·209	64·239	72·269	80·299	25
40	8·021	16·042	24·064	32·085	40·106	48·127	56·148	64·170	72·191	80·212	20
45	8·012	16·025	24·037	32·050	40·062	48·075	56·087	64·100	72·112	80·125	15
50	8·004	16·008	24·001	32·015	40·019	48·023	56·027	64·030	72·034	80·038	10
55	7·995	15·990	23·985	31·980	39·975	47·971	55·966	63·961	71·956	79·951	5
60	7·986	15·973	23·959	31·945	39·931	47·918	55·904	63·890	71·877	79·863	53° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

53 Deg. Departures, or Difference of Levels

TABLE II.

Departures, or Difference of Levels

	Sines	
36° 0′	·58778	60′
1	·58802	59
2	·58826	58
3	·58849	57
4	·58873	56
5	·58896	55
6	·58920	54
7	·58943	53
8	·58967	52
9	·58990	51
10	·59014	50
11	·59037	49
12	·59061	48
13	·59084	47
14	·59107	46
15	·59131	45
16	·59154	44
17	·59178	43
18	·59201	42
19	·59225	41
20	·59248	40
21	·59272	39
22	·59295	38
23	·59318	37
24	·59342	36
25	·59365	35
26	·59389	34
27	·59412	33
28	·59435	32
29	·59459	31
30	·59482	30
31	·59506	29
32	·59529	28
33	·59552	27
34	·59576	26
35	·59599	25
36	·59622	24
37	·59646	23
38	·59669	22
39	·59692	21
40	·59716	20
41	·59739	19
42	·59762	18
43	·59786	17
44	·59809	16
45	·59832	15
46	·59856	14
47	·59879	13
48	·59902	12
49	·59926	11
50	·59949	10
51	·59972	9
52	·59995	8
53	·60019	7
54	·60042	6
55	·60065	5
56	·60088	4
57	·60112	3
58	·60135	2
59	·60158	1
60	·60181	0°53
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

36 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
36° 0′	5·878	11·756	17·634	23·511	29·389	35·267	41·145	47·023	52·901	58·778	60′
5	5·890	11·779	17·669	23·558	29·448	35·338	41·227	47·117	53·006	58·896	55
10	5·901	11·803	17·704	23·605	29·506	35·408	41·309	47·211	53·112	59·014	50
15	5·913	11·826	17·739	23·652	29·565	35·479	41·391	47·305	53·217	59·131	45
20	5·925	11·850	17·774	23·699	29·624	35·549	41·474	47·399	53·323	59·248	40
25	5·937	11·873	17·810	23·746	29·683	35·619	41·556	47·492	53·429	59·365	35
30	5·948	11·896	17·845	23·792	29·741	35·689	41·638	47·586	53·534	59·482	30
35	5·960	11·920	17·880	23·840	29·800	35·759	41·719	47·679	53·639	59·599	25
40	5·972	11·943	17·915	23·886	29·858	35·829	41·801	47·773	53·744	59·716	20
45	5·983	11·966	17·950	23·933	29·916	35·899	41·883	47·866	53·849	59·832	15
50	5·995	11·990	17·985	23·980	29·974	35·969	41·964	47·960	53·954	59·949	10
55	6·007	12·013	18·020	24·026	30·033	36·039	42·046	48·052	54·059	60·065	5
60	6·018	12·036	18·054	24·073	30·091	36·109	42·127	48·145	54·163	60·181	53° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

53 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
37° 0'	·79864	60'
1	·79846	59
2	·79828	58
3	·79811	57
4	·79793	56
5	·79776	55
6	·79758	54
7	·79741	53
8	·79723	52
9	·79706	51
10	·79688	50
11	·79670	49
12	·79653	48
13	·79635	47
14	·79618	46
15	·79600	45
16	·79583	44
17	·79565	43
18	·79547	42
19	·79530	41
20	·79512	40
21	·79494	39
22	·79477	38
23	·79459	37
24	·79441	36
25	·79424	35
26	·79406	34
27	·79388	33
28	·79371	32
29	·79353	31
30	·79335	30
31	·79318	29
32	·79300	28
33	·79282	27
34	·79264	26
35	·79247	25
36	·79229	24
37	·79211	23
38	·79193	22
39	·79176	21
40	·79157	20
41	·79140	19
42	·79122	18
43	·79105	17
44	·79087	16
45	·79069	15
46	·79051	14
47	·79033	13
48	·79015	12
49	·78998	11
50	·78980	10
51	·78962	9
52	·78944	8
53	·78926	7
54	·78908	6
55	·78890	5
56	·78873	4
57	·78855	3
58	·78837	2
59	·78819	1
60	·78801	0° 52
	Sines	

Departures, or Difference of Levels

37 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
37° 0'	7·986	15·973	23·959	31·945	39·931	47·918	55·904	63·890	71·877	79·863	60'
5	7·978	15·955	23·933	31·910	39·888	47·866	55·843	63·821	71·798	79·776	55
10	7·969	15·938	23·906	31·875	39·844	47·813	55·782	63·750	71·719	79·688	50
15	7·960	15·920	23·880	31·840	39·800	47·760	55·720	63·680	71·640	79·600	45
20	7·951	15·902	23·854	31·805	39·756	47·707	55·658	63·609	71·561	79·512	40
25	7·942	15·885	23·827	31·770	39·712	47·654	55·597	63·539	71·482	79·424	35
30	7·933	15·867	23·800	31·734	39·667	47·601	55·534	63·468	71·401	79·335	30
35	7·925	15·849	23·774	31·699	39·623	47·548	55·473	63·398	71·322	79·247	25
40	7·916	15·832	23·747	31·663	39·579	47·475	55·391	63·306	71·222	79·138	20
45	7·907	15·814	23·721	31·628	39·534	47·441	55·348	63·255	71·162	79·069	15
50	7·898	15·796	23·694	31·592	39·490	47·388	55·286	63·184	71·082	78·980	10
55	7·889	15·778	23·667	31·556	39·445	47·334	55·223	63·112	71·001	78·890	5
60	7·880	15·760	23·640	31·520	39·400	47·281	55·161	63·041	70·921	78·801	52° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

52 Deg. Departures, or Difference of Levels.

Departures, or Difference of Levels		
	Sines	
37° 0′	·60181	60′
1	·60205	59
2	·60228	58
3	·60251	57
4	·60274	56
5	·60298	55
6	·60321	54
7	·60344	53
8	·60367	52
9	·60390	51
10	·60414	50
11	·60437	49
12	·60460	48
13	·60483	47
14	·60506	46
15	·60529	45
16	·60552	44
17	·60576	43
18	·60599	42
19	·60622	41
20	·60645	40
21	·60668	39
22	·60691	38
23	·60714	37
24	·60738	36
25	·60761	35
26	·60784	34
27	·60807	33
28	·60830	32
29	·60853	31
30	·60876	30
31	·60899	29
32	·60922	28
33	·60945	27
34	·60968	26
35	·60991	25
36	·61014	24
37	·61038	23
38	·61061	22
39	·61084	21
40	·61107	20
41	·61130	19
42	·61153	18
43	·61176	17
44	·61199	16
45	·61222	15
46	·61245	14
47	·61268	13
48	·61291	12
49	·61314	11
50	·61337	10
51	·61360	9
52	·61383	8
53	·61406	7
54	·61428	6
55	·61451	5
56	·61474	4
57	·61497	3
58	·61520	2
59	·61543	1
60	·61566	0° 52
	Cosines	
Latitudes, or Horizontal Distances for Difference of Levels		

DEPARTURES, OR DIFFERENCE OF LEVELS

37 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
37° 0′	6·018	12·036	18·054	24·073	30·091	36·109	42·127	48·145	54·163	60·181	60′
5	6·030	12·060	18·089	24·119	30·149	36·179	42·208	48·238	54·268	60·298	55
10	6·041	12·083	18·124	24·165	30·207	36·248	42·289	48·331	54·372	60·414	50
15	6·053	12·106	18·159	24·212	30·265	36·318	42·371	48·423	54·476	60·529	45
20	6·064	12·129	18·193	24·258	30·322	36·387	42·452	48·516	54·581	60·645	40
25	6·076	12·152	18·228	24·304	30·380	36·456	42·532	48·609	54·684	60·761	35
30	6·088	12·175	18·263	24·350	30·438	36·526	42·613	48·701	54·788	60·876	30
35	6·099	12·198	18·297	24·397	30·496	36·595	42·694	48·793	54·892	60·991	25
40	6·111	12·221	18·332	24·443	30·553	36·664	42·775	48·885	54·996	61·107	20
45	6·122	12·244	18·366	24·489	30·611	36·733	42·855	48·977	55·100	61·222	15
50	6·134	12·267	18·401	24·535	30·669	36·802	42·936	49·069	55·203	61·337	10
55	6·145	12·290	18·435	24·581	30·726	36·871	43·016	49·161	55·306	61·451	5
60	6·157	12·313	18·470	24·626	30·783	36·940	43·096	49·253	55·409	61·566	52° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

52 Deg. Latitudes, or Horizontal Distances for Difference of Levels

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
38° 0′	·78801	60′
1	·78783	59
2	·78765	58
3	·78747	57
4	·78729	56
5	·78711	55
6	·78693	54
7	·78676	53
8	·78658	52
9	·78640	51
10	·78622	50
11	·78604	49
12	·78586	48
13	·78568	47
14	·78550	46
15	·78532	45
16	·78514	44
17	·78496	43
18	·78478	42
19	·78460	41
20	·78442	40
21	·78423	39
22	·78405	38
23	·78387	37
24	·78369	36
25	·78351	35
26	·78333	34
27	·78315	33
28	·78297	32
29	·78279	31
30	·78261	30
31	·78243	29
32	·78225	28
33	·78206	27
34	·78188	26
35	·78170	25
36	·78152	24
37	·78134	23
38	·78116	22
39	·78098	21
40	·78079	20
41	·78061	19
42	·78043	18
43	·78025	17
44	·78007	16
45	·77988	15
46	·77970	14
47	·77952	13
48	·77934	12
49	·77916	11
50	·77897	10
51	·77879	9
52	·77861	8
53	·77843	7
54	·77824	6
55	·77806	5
56	·77788	4
57	·77769	3
58	·77751	2
59	·77733	1
60	·77715	0 51
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

38 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
38° 0′	7·880	15·760	23·640	31·520	39·400	47·281	55·161	63·041	70·921	78·801	60′
5	7·871	15·742	23·613	31·484	39·355	47·226	55·097	62·969	70·840	78·711	55
10	7·862	15·724	23·587	31·449	39·311	47·173	55·035	62·897	70·760	78·622	50
15	7·853	15·706	23·560	31·413	39·266	47·119	54·972	62·826	70·679	78·532	45
20	7·844	15·688	23·532	31·376	39·220	47·065	54·909	62·753	70·597	78·441	40
25	7·835	15·670	23·505	31·340	39·175	47·011	54·846	62·681	70·516	78·351	35
30	7·826	15·652	23·478	31·304	39·130	46·957	54·783	62·609	70·435	78·261	30
35	7·817	15·634	23·451	31·268	39·085	46·902	54·719	62·536	70·353	78·170	25
40	7·808	15·616	23·424	31·232	39·039	46·847	54·655	62·463	70·271	78·079	20
45	7·799	15·598	23·396	31·195	38·994	46·793	54·592	62·390	70·189	77·988	15
50	7·790	15·579	23·369	31·159	38·948	46·738	54·528	62·318	70·107	77·897	10
55	7·781	15·561	23·342	31·122	38·903	46·684	54·464	62·245	70·025	77·806	5
60	7·771	15·543	23·314	31·086	38·857	46·629	54·400	62·172	69·943	77·715	51° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

51 Deg. Departures, or Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

Departures, or Difference of Levels

	Sines	
38° 0′	·61566	60′
1	·61589	59
2	·61612	58
3	·61635	57
4	·61658	56
5	·61681	55
6	·61704	54
7	·61726	53
8	·61749	52
9	·61772	51
10	·61795	50
11	·61818	49
12	·61841	48
13	·61864	47
14	·61887	46
15	·61909	45
16	·61932	44
17	·61955	43
18	·61978	42
19	·62001	41
20	·62024	40
21	·62046	39
22	·62069	38
23	·62092	37
24	·62115	36
25	·62138	35
26	·62160	34
27	·62183	33
28	·62206	32
29	·62229	31
30	·62251	30
31	·62274	29
32	·62297	28
33	·62320	27
34	·62342	26
35	·62365	25
36	·62388	24
37	·62411	23
38	·62433	22
39	·62456	21
40	·62479	20
41	·62502	19
42	·62524	18
43	·62547	17
44	·62570	16
45	·62592	15
46	·62615	14
47	·62638	13
48	·62660	12
49	·62683	11
50	·62706	10
51	·62728	9
52	·62751	8
53	·62774	7
54	·62796	6
55	·62819	5
56	·62842	4
57	·62864	3
58	·62887	2
59	·62909	1
60	·62932	0°51
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

38 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
38° 0′	6·157	12·313	18·470	24·626	30·783	36·940	43·096	49·253	55·409	61·566	60′
5	6·168	12·336	18·504	24·672	30·840	37·008	43·176	49·344	55·513	61·681	55
10	6·179	12·359	18·538	24·718	30·898	37·077	43·257	49·436	55·616	61·795	50
15	6·191	12·382	18·573	24·764	30·955	37·146	43·337	49·527	55·718	61·909	45
20	6·202	12·405	18·607	24·809	31·012	37·214	43·416	49·619	55·821	62·024	40
25	6·214	12·427	18·641	24·855	31·069	37·282	43·496	49·710	55·924	62·138	35
30	6·225	12·450	18·675	24·901	31·126	37·351	43·576	49·801	56·026	62·251	30
35	6·236	12·473	18·710	24·946	31·183	37·419	43·656	49·892	56·129	62·365	25
40	6·248	12·496	18·744	24·991	31·239	37·487	43·735	49·983	56·231	62·479	20
45	6·259	12·518	18·778	25·037	31·296	37·555	43·815	50·074	56·333	62·592	15
50	6·271	12·541	18·812	25·082	31·353	37·623	43·894	50·165	56·435	62·706	10
55	6·282	12·564	18·846	25·128	31·409	37·691	43·973	50·255	56·537	62·819	5
60	6·293	12·586	18·880	25·173	31·466	37·759	44·052	50·346	56·639	62·932	51° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

51 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
39° 0′	·77715	60′
1	·77696	59
2	·77678	58
3	·77660	57
4	·77641	56
5	·77623	55
6	·77605	54
7	·77586	53
8	·77568	52
9	·77550	51
10	·77531	50
11	·77513	49
12	·77494	48
13	·77476	47
14	·77458	46
15	·77439	45
16	·77421	44
17	·77402	43
18	·77384	42
19	·77366	41
20	·77347	40
21	·77329	39
22	·77310	38
23	·77292	37
24	·77273	36
25	·77255	35
26	·77236	34
27	·77218	33
28	·77199	32
29	·77181	31
30	·77162	30
31	·77144	29
32	·77125	28
33	·77107	27
34	·77088	26
35	·77070	25
36	·77051	24
37	·77033	23
38	·77014	22
39	·76996	21
40	·76977	20
41	·76958	19
42	·76940	18
43	·76921	17
44	·76903	16
45	·76884	15
46	·76866	14
47	·76847	13
48	·76828	12
49	·76810	11
50	·76791	10
51	·76772	9
52	·76754	8
53	·76735	7
54	·76716	6
55	·76698	5
56	·76679	4
57	·76660	3
58	·76642	2
59	·76623	1
60	·76604	0·50
	Sines	

Departures, or Difference of Levels

39 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
39° 0′	7·771	15·543	23·314	31·086	38·857	46·629	54·400	62·172	69·943	77·715	60′
5	7·762	15·524	23·287	31·049	38·811	46·574	54·336	62·098	69·861	77·623	55
10	7·753	15·506	23·259	31·012	38·765	46·519	54·272	62·025	69·778	77·531	50
15	7·744	15·488	23·232	30·976	38·719	46·463	54·207	61·951	69·695	77·439	45
20	7·735	15·469	23·204	30·939	38·673	46·408	54·143	61·878	69·612	77·347	40
25	7·725	15·451	23·176	30·902	38·627	46·353	54·078	61·804	69·529	77·255	35
30	7·716	15·432	23·148	30·865	38·581	46·297	54·013	61·730	69·446	77·162	30
35	7·707	15·414	23·121	30·828	38·535	46·242	53·949	61·656	69·363	77·070	25
40	7·698	15·395	23·093	30·791	38·488	46·186	53·884	61·582	69·279	76·977	20
45	7·688	15·377	23·065	30·754	38·442	46·130	53·819	61·507	69·196	76·884	15
50	7·679	15·358	23·037	30·716	38·395	46·075	53·754	61·432	69·112	76·791	10
55	7·670	15·340	23·009	30·679	38·349	46·019	53·689	61·358	69·028	76·698	5
60	7·660	15·321	22·981	30·642	38·302	45·962	53·623	61·283	68·943	76·604	50° 0
	10	20	30	40	50	60	70	80	90	100	

DEPARTURES, OR DIFFERENCE OF LEVELS

50 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
39° 0'	·62932	60'
1	·62955	59
2	·62977	58
3	·63000	57
4	·63022	56
5	·63045	55
6	·63068	54
7	·63090	53
8	·63113	52
9	·63135	51
10	·63158	50
11	·63180	49
12	·63203	48
13	·63225	47
14	·63248	46
15	·63270	45
16	·63293	44
17	·63316	43
18	·63338	42
19	·63361	41
20	·63383	40
21	·63406	39
22	·63428	38
23	·63451	37
24	·63473	36
25	·63495	35
26	·63518	34
27	·63540	33
28	·63563	32
29	·63585	31
30	·63608	30
31	·63630	29
32	·63653	28
33	·63675	27
34	·63698	26
35	·63720	25
36	·63742	24
37	·63765	23
38	·63787	22
39	·63809	21
40	·63832	20
41	·63854	19
42	·63877	18
43	·63899	17
44	·63921	16
45	·63944	15
46	·63966	14
47	·63989	13
48	·64011	12
49	·64033	11
50	·64056	10
51	·64078	9
52	·64100	8
53	·64123	7
54	·64145	6
55	·64167	5
56	·64190	4
57	·64212	3
58	·64234	2
59	·64256	1
60	·64279	0·50
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

39 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
39° 0'	6·293	12·586	18·880	25·173	31·466	37·759	44·052	50·346	56·639	62·932	60'
5	6·304	12·609	18·913	25·218	31·522	37·827	44·131	50·436	56·740	63·045	55
10	6·316	12·632	18·947	25·263	31·579	37·895	44·210	50·526	56·842	63·158	50
15	6·327	12·654	18·981	25·308	31·635	37·962	44·289	50·616	56·943	63·270	45
20	6·338	12·677	19·015	25·353	31·691	38·030	44·368	50·706	57·045	63·383	40
25	6·350	12·699	19·049	25·398	31·748	38·097	44·447	50·796	57·146	63·495	35
30	6·361	12·721	19·082	25·443	31·804	38·165	44·525	50·886	57·247	63·608	30
35	6·372	12·744	19·116	25·488	31·860	38·232	44·604	50·976	57·348	63·720	25
40	6·383	12·766	19·150	25·533	31·916	38·299	44·682	51·066	57·449	63·832	20
45	6·394	12·789	19·183	25·578	31·972	38·366	44·761	51·155	57·549	63·944	15
50	6·406	12·811	19·217	25·622	32·028	38·433	44·839	51·244	57·650	64·056	10
55	6·417	12·833	19·250	25·667	32·084	38·500	44·917	51·334	57·751	64·167	5
60	6·428	12·856	19·285	25·712	32·140	38·568	44·996	51·424	57·852	64·280	50° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

50 Deg. Latitudes, or Horizontal Distances for Difference of Levels

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
40° 0′	·76604	60′
1	·76586	59
2	·76567	58
3	·76548	57
4	·76530	56
5	·76511	55
6	·76492	54
7	·76473	53
8	·76455	52
9	·76436	51
10	·76417	50
11	·76398	49
12	·76380	48
13	·76361	47
14	·76342	46
15	·76323	45
16	·76304	44
17	·76286	43
18	·76267	42
19	·76248	41
20	·76229	40
21	·76210	39
22	·76191	38
23	·76173	37
24	·76154	36
25	·76135	35
26	·76116	34
27	·76097	33
28	·76078	32
29	·76059	31
30	·76041	30
31	·76022	29
32	·76003	28
33	·75984	27
34	·75965	26
35	·75946	25
36	·75927	24
37	·75908	23
38	·75889	22
39	·75870	21
40	·75851	20
41	·75832	19
42	·75813	18
43	·75794	17
44	·75775	16
45	·75756	15
46	·75737	14
47	·75718	13
48	·75699	12
49	·75680	11
50	·75661	10
51	·75642	9
52	·75623	8
53	·75604	7
54	·75585	6
55	·75566	5
56	·75547	4
57	·75528	3
58	·75509	2
59	·75490	1
60	·75471	0°49
	Sines	

Departures, or Difference of Levels

40 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
40° 0′	7·660	15·321	22·981	30·642	38·302	45·962	53·623	61·283	68·943	76·604	60′
5	7·651	15·302	22·953	30·604	38·255	45·907	53·558	61·209	68·860	76·511	55
10	7·642	15·283	22·925	30·567	38·208	45·850	53·492	61·134	68·775	76·417	50
15	7·632	15·265	22·897	30·529	38·161	45·794	53·426	61·058	68·691	76·323	45
20	7·623	15·246	22·869	30·492	38·114	45·737	53·360	60·983	68·606	76·229	40
25	7·613	15·227	22·840	30·454	38·067	45·681	53·294	60·908	68·521	76·135	35
30	7·604	15·208	22·812	30·416	38·020	45·625	53·229	60·833	68·437	76·041	30
35	7·595	15·189	22·784	30·378	37·973	45·568	53·162	60·757	68·351	75·946	25
40	7·585	15·170	22·755	30·340	37·925	45·511	53·096	60·681	68·266	75·851	20
45	7·576	15·151	22·727	30·302	37·878	45·454	53·029	60·605	68·180	75·756	15
50	7·566	15·132	22·698	30·264	37·830	45·397	52·963	60·529	68·095	75·661	10
55	7·557	15·113	22·670	30·226	37·783	45·340	52·896	60·453	68·009	75·566	5
60	7·547	15·094	22·641	30·188	37·735	45·283	52·830	60·377	67·924	75·471	49° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

49 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
40° 0′	·64279	60′
1	·64301	59
2	·64323	58
3	·64346	57
4	·64368	56
5	·64390	55
6	·64412	54
7	·64435	53
8	·64457	52
9	·64479	51
10	·64501	50
11	·64524	49
12	·64546	48
13	·64568	47
14	·64590	46
15	·64612	45
16	·64635	44
17	·64657	43
18	·64679	42
19	·64701	41
20	·64723	40
21	·64745	39
22	·64768	38
23	·64790	37
24	·64812	36
25	·64834	35
26	·64856	34
27	·64878	33
28	·64901	32
29	·64923	31
30	·64945	30
31	·64967	29
32	·64989	28
33	·65011	27
34	·65033	26
35	·65055	25
36	·65077	24
37	·65099	23
38	·65122	22
39	·65144	21
40	·65166	20
41	·65188	19
42	·65210	18
43	·65232	17
44	·65254	16
45	·65276	15
46	·65298	14
47	·65320	13
48	·65342	12
49	·65364	11
50	·65386	10
51	·65408	9
52	·65430	8
53	·65452	7
54	·65474	6
55	·65496	5
56	·65518	4
57	·65540	3
58	·65562	2
59	·65583	1
60	·65606	0 ′49
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

40 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
40° 0′	6·428	12·856	19·285	25·712	32·140	38·568	44·996	51·424	57·852	64·280	60′
5	6·439	12·878	19·317	25·756	32·195	38·634	45·073	51·512	57·951	64·390	55
10	6·450	12·900	19·350	25·800	32·251	38·701	45·151	51·601	58·051	64·501	50
15	6·461	12·922	19·384	25·845	32·306	38·767	45·229	51·690	58·151	64·612	45
20	6·472	12·945	19·417	25·889	32·362	38·834	45·306	51·779	58·251	64·723	40
25	6·483	12·969	19·450	25·934	32·417	38·900	45·384	51·867	58·351	64·834	35
30	6·494	12·989	19·483	25·978	32·472	38·967	45·461	51·956	58·450	64·945	30
35	6·505	13·011	19·517	26·022	32·528	39·033	45·539	52·044	58·550	65·055	25
40	6·517	13·033	19·550	26·066	32·583	39·099	45·616	52·133	58·649	65·166	20
45	6·528	13·055	19·583	26·110	32·638	39·166	45·693	52·221	58·748	65·276	15
50	6·539	13·077	19·616	26·154	32·693	39·232	45·770	52·309	58·847	65·386	10
55	6·550	13·099	19·649	26·198	32·748	39·298	45·847	52·397	58·946	65·496	5
60	6·561	13·121	19·681	26·242	32·803	39·363	45·924	52·485	59·045	65·606	49° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

49 Deg. Latitudes, or Horizontal Distances for Difference of Levels

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
41° 0'	·75471	60'
1	·75452	59
2	·75433	58
3	·75414	57
4	·75395	56
5	·75375	55
6	·75356	54
7	·75337	53
8	·75318	52
9	·75299	51
10	·75280	50
11	·75261	49
12	·75241	48
13	·75222	47
14	·75203	46
15	·75184	45
16	·75165	44
17	·75146	43
18	·75126	42
19	·75107	41
20	·75088	40
21	·75069	39
22	·75050	38
23	·75030	37
24	·75011	36
25	·74992	35
26	·74973	34
27	·74953	33
28	·74934	32
29	·74915	31
30	·74896	30
31	·74876	29
32	·74857	28
33	·74838	27
34	·74818	26
35	·74799	25
36	·74780	24
37	·74760	23
38	·74741	22
39	·74722	21
40	·74702	20
41	·74683	19
42	·74664	18
43	·74644	17
44	·74625	16
45	·74606	15
46	·74586	14
47	·74567	13
48	·74548	12
49	·74528	11
50	·74509	10
51	·74489	9
52	·74470	8
53	·74451	7
54	·74431	6
55	·74412	5
56	·74392	4
57	·74373	3
58	·74353	2
59	·74334	1
60	·74314	0·48
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

41 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
41° 0'	7·547	15·094	22·641	30·188	37·735	45·283	52·830	60·377	67·924	75·471	60'
5	7·537	15·075	22·612	30·150	37·687	45·225	52·762	60·300	67·837	75·375	55
10	7·528	15·056	22·584	30·112	37·640	45·168	52·696	60·224	67·752	75·280	50
15	7·518	15·037	22·555	30·074	37·592	45·110	52·629	60·147	67·666	75·184	45
20	7·509	15·018	22·526	30·035	37·544	45·053	52·562	60·070	67·579	75·088	40
25	7·499	14·998	22·498	29·997	37·496	44·995	52·494	59·994	67·493	74·992	35
30	7·489	14·979	22·468	29·958	37·447	44·937	52·426	59·916	67·405	74·895	30
35	7·480	14·960	22·440	29·920	37·399	44·879	52·359	59·839	67·319	74·799	25
40	7·470	14·940	22·411	29·881	37·351	44·821	52·291	59·762	67·232	74·702	20
45	7·461	14·921	22·382	29·842	37 303	44·764	52·224	59·685	67·145	74·606	15
50	7·451	14·902	22·353	29·804	37·254	44·705	52·156	59·607	67·058	74·509	10
55	7·441	14·882	22·324	29·765	37·206	44·647	52·088	59·530	66·971	74·412	5
60	7·431	14·863	22·294	29·725	37·157	44·588	52·020	59·451	66·883	74·314	48° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

48 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
41° 0'	·65606	60'
1	·65628	59
2	·65650	58
3	·65672	57
4	·65694	56
5	·65716	55
6	·65737	54
7	·65759	53
8	·65781	52
9	·65803	51
10	·65825	50
11	·65847	49
12	·65869	48
13	·65891	47
14	·65913	46
15	·65935	45
16	·65956	44
17	·65978	43
18	·66000	42
19	·66022	41
20	·66044	40
21	·66066	39
22	·66087	38
23	·66109	37
24	·66131	36
25	·66153	35
26	·66175	34
27	·66196	33
28	·66218	32
29	·66240	31
30	·66262	30
31	·66284	29
32	·66306	28
33	·66327	27
34	·66349	26
35	·66371	25
36	·66393	24
37	·66414	23
38	·66436	22
39	·66458	21
40	·66480	20
41	·66501	19
42	·66523	18
43	·66545	17
44	·66566	16
45	·66588	15
46	·66610	14
47	·66632	13
48	·66653	12
49	·66675	11
50	·66697	10
51	·66718	9
52	·66740	8
53	·66762	7
54	·66783	6
55	·66805	5
56	·66836	4
57	·66848	3
58	·66870	2
59	·66891	1
60	·66913	0' 48
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

41 **Deg.** Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
41° 0'	6·561	13·121	19·681	26·242	32·803	39·363	45·924	52·485	59·045	65·606	60'
5	6·572	13·143	19·715	26·286	32·858	39·429	46·001	52·572	59·144	65·716	55
10	6·582	13·165	19·747	26·330	32·913	39·495	46·078	52·660	59·243	65·825	50
15	6·593	13·187	19·780	26·374	32·967	39·561	46·154	52·748	59·341	65·935	45
20	6·604	13·209	19·813	26·417	33·022	39·626	46·231	52·835	59·439	66·044	40
25	6·615	13·231	19·846	26·461	33·076	39·692	46·307	52·922	59·538	66·153	35
30	6·626	13·252	19·879	26·505	33·131	39·757	46·383	53·010	59·636	66·262	30
35	6·637	13·274	19·911	26·548	33·185	39·822	46·460	53·097	59·734	66·371	25
40	6·648	13·296	19·944	26·592	33·240	39·888	46·536	53·184	59·831	66·480	20
45	6·659	13·318	19·976	26·635	33·294	39·953	46·612	53·270	59·929	66·588	15
50	6·670	13·339	20·009	26·678	33·348	40·018	46·688	53·357	60·027	66·697	10
55	6·680	13·361	20·041	26·722	33·402	40·083	46·763	53·444	60·124	66·805	5
60	6·691	13·383	20·074	26·765	33·456	40·148	46·839	53·530	60·222	66·913	48° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

48 **Deg.** Latitudes, or Horizontal Distances for Difference of Levels

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
42° 0′	·74314	60′
1	·74295	59
2	·74275	58
3	·74256	57
4	·74237	56
5	·74217	55
6	·74198	54
7	·74178	53
8	·74159	52
9	·74139	51
10	·74119	50
11	·74100	49
12	·74080	48
13	·74061	47
14	·74041	46
15	·74022	45
16	·74002	44
17	·73983	43
18	·73963	42
19	·73943	41
20	·73924	40
21	·73904	39
22	·73885	38
23	·73865	37
24	·73845	36
25	·73826	35
26	·73806	34
27	·73787	33
28	·73767	32
29	·73747	31
30	·73728	30
31	·73708	29
32	·73688	28
33	·73669	27
34	·73649	26
35	·73629	25
36	·73610	24
37	·73590	23
38	·73570	22
39	·73551	21
40	·73531	20
41	·73511	19
42	·73491	18
43	·73472	17
44	·73452	16
45	·73432	15
46	·73412	14
47	·73393	13
48	·73373	12
49	·73353	11
50	·73333	10
51	·73314	9
52	·73294	8
53	·73274	7
54	·73254	6
55	·73234	5
56	·73215	4
57	·73195	3
58	·73175	2
59	·73155	1
60	·73135	0° 47
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

42 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
42° 0′	7·431	14·863	22·294	29·725	37·157	44·588	52·020	59·451	66·883	74·314	60′
5	7·422	14·843	22·265	29·687	37·108	44·530	51·952	59·374	66·795	74·217	55
10	7·412	14·824	22·236	29·648	37·059	44·471	51·883	59·295	66·707	74·119	50
15	7·402	14·804	22·207	29·609	37·011	44·413	51·815	59·218	66·620	74·022	45
20	7·392	14·785	22·177	29·570	36·962	44·354	51·747	59·139	66·532	73·924	40
25	7·383	14·765	22·148	29·530	36·913	44·296	51·678	59·061	66·443	73·826	35
30	7·373	14·746	22·118	29·491	36·864	44·237	51·610	58·982	66·355	73·728	30
35	7·363	14·726	22·089	29·452	36·814	44·177	51·540	58·903	66·266	73·629	25
40	7·353	14·706	22·059	29·412	36·765	44·119	51·472	58·825	66·178	73·531	20
45	7·343	14·686	22·030	29·373	36·716	44·059	51·402	58·746	66·089	73·432	15
50	7·333	14·667	22·000	29·333	36·666	44·000	51·333	58·666	66·000	73·333	10
55	7·323	14·647	21·970	29·294	36·617	43·940	51·264	58·587	65·911	73·234	5
60	7·313	14·627	21·940	29·254	36·567	43·881	51·194	58·508	65·821	73·135	0 47°
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

47 Deg. Departures, or Difference of Levels

TABLE II.

Departures, or Difference of Levels

	Sines	
42° 0	·66913	60′
1	·66935	59
2	·66956	58
3	·66978	57
4	·66999	56
5	·67021	55
6	·67043	54
7	·67064	53
8	·67086	52
9	·67107	51
10	·67129	50
11	·67150	49
12	·67172	48
13	·67194	47
14	·67215	46
15	·67237	45
16	·67258	44
17	·67278	43
18	·67301	42
19	·67323	41
20	·67344	40
21	·67366	39
22	·67387	38
23	·67409	37
24	·67430	36
25	·67452	35
26	·67473	34
27	·67495	33
28	·67516	32
29	·67538	31
30	·67559	30
31	·67580	29
32	·67602	28
33	·67623	27
34	·67645	26
35	·67666	25
36	·67688	24
37	·67709	23
38	·67730	22
39	·67752	21
40	·67773	20
41	·67795	19
42	·67816	18
43	·67837	17
44	·67859	16
45	·67880	15
46	·67901	14
47	·67923	13
48	·67944	12
49	·67965	11
50	·67987	10
51	·68008	9
52	·68029	8
53	·68051	7
54	·68072	6
55	·68093	5
56	·68115	4
57	·68136	3
58	·68157	2
59	·68179	1
60	·68200	0° 47
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

42 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	Measured Lengths
42° 0′	6·691	13·383	20·074	26·765	33·456	40·148	46·839	53·530	60·222	66·913	60′
5	6·702	13·404	20·106	26·808	33·510	40·213	46·915	53·617	60·319	67·021	55
10	6·713	13·426	20·139	26·852	33·564	40·277	46·990	53·703	60·416	67·129	50
15	6·724	13·447	20·171	26·895	33·618	40·342	47·066	53·789	60·513	67·237	45
20	6·734	13·469	20·203	26·938	33·672	40·407	47·141	53·875	60·610	67·344	40
25	6·745	13·490	20·235	26·981	33·726	40·471	47·216	53·961	60·706	67·452	35
30	6·756	13·512	20·268	27·024	33·779	40·535	47·291	54·047	60·803	67·559	30
35	6·767	13·533	20·300	27·066	33·833	40·600	47·366	54·133	60·900	67·666	25
40	6·777	13·555	20·332	27·109	33·887	40·664	47·441	54·219	60·996	67·773	20
45	6·788	13·576	20·364	27·152	33·940	40·728	47·516	54·304	61·092	67·880	15
50	6·799	13·597	20·396	27·195	33·993	40·792	47·591	54·389	61·188	67·987	10
55	6·809	13·619	20·428	27·237	34·047	40·856	47·665	54·475	61·284	68·093	5
60	6·820	13·640	20·460	27·280	34·100	40·920	47·740	54·560	61·380	68·200	47° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

47 Deg. Latitudes, or Horizontal Distances for Difference of Levels

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
43° 0′	·73135	60′
1	·73115	59
2	·73096	58
3	·73076	57
4	·73056	56
5	·73036	55
6	·73016	54
7	·72996	53
8	·72976	52
9	·72957	51
10	·72937	50
11	·72917	49
12	·72897	48
13	·72877	47
14	·72857	46
15	·72837	45
16	·72817	44
17	·72797	43
18	·72777	42
19	·72757	41
20	·72737	40
21	·72717	39
22	·72697	38
23	·72677	37
24	·72657	36
25	·72637	35
26	·72617	34
27	·72597	33
28	·72577	32
29	·72557	31
30	·72537	30
31	·72517	29
32	·72497	28
33	·72477	27
34	·72457	26
35	·72437	25
36	·72417	24
37	·72397	23
38	·72377	22
39	·72357	21
40	·72337	20
41	·72317	19
42	·72297	18
43	·72277	17
44	·72256	16
45	·72236	15
46	·72216	14
47	·72196	13
48	·72176	12
49	·72156	11
50	·72136	10
51	·72116	9
52	·72095	8
53	·72075	7
54	·72055	6
55	·72035	5
56	·72015	4
57	·71995	3
58	·71974	2
59	·71954	1
60	·71934	0° 46
	Sines	

Departures, or Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

43 Deg. Latitudes, or Horizontal Distances for Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
43° 0′	7·313	14·627	21·940	29·254	36·567	43·881	51·194	58·508	65·821	73·135	60′
5	7·304	14·607	21·911	29·214	36·518	43·822	51·125	58·429	65·732	73·036	55
10	7·294	14·587	21·881	29·175	36·468	43·762	51·056	58·350	65·643	72·937	50
15	7·284	14·567	21·851	29·135	36·418	43·702	50·986	58·270	65·553	72·837	45
20	7·274	14·547	21·821	29·095	36·368	43·642	50·916	58·190	65·463	72·737	40
25	7·264	14·527	21·791	29·055	36·318	43·582	50·846	58·110	65·373	72·637	35
30	7·254	14·507	21·761	29·015	36·268	43·522	50·776	58·030	65·283	72·537	30
35	7·244	14·487	21·731	28·975	36·218	43·462	50·706	57·950	65·193	72·437	25
40	7·234	14·467	21·701	28·935	36·168	43·402	50·636	57·870	65·103	72·337	20
45	7·224	14·447	21·671	28·894	36·118	43·342	50·565	57·789	65·012	72·236	15
50	7·214	14·427	21·641	28·854	36·068	43·282	50·495	57·709	64·922	72·136	10
55	7·203	14·407	21·610	28·814	36·017	43·221	50·424	57·628	64·831	72·035	5
60	7·193	14·387	21·580	28·774	35·967	43·160	50·354	57·547	64·741	71·934	46° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

46 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
43° 0′	·68200	60′
1	·68221	59
2	·68242	58
3	·68263	57
4	·68285	56
5	·68306	55
6	·68327	54
7	·68349	53
8	·68370	52
9	·68391	51
10	·68412	50
11	·68433	49
12	·68455	48
13	·68476	47
14	·68497	46
15	·68518	45
16	·68539	44
17	·68561	43
18	·68582	42
19	·68603	41
20	·68624	40
21	·68645	39
22	·68666	38
23	·68688	37
24	·68709	36
25	·68730	35
26	·68751	34
27	·68772	33
28	·68793	32
29	·68814	31
30	·68835	30
31	·68856	29
32	·68878	28
33	·68899	27
34	·68920	26
35	·68941	25
36	·68962	24
37	·68983	23
38	·69004	22
39	·69025	21
40	·69046	20
41	·69067	19
42	·69088	18
43	·69109	17
44	·69130	16
45	·69151	15
46	·69172	14
47	·69193	13
48	·69214	12
49	·69235	11
50	·69256	10
51	·69277	9
52	·69298	8
53	·69319	7
54	·69340	6
55	·69361	5
56	·69382	4
57	·69403	3
58	·69424	2
59	·69445	1
60	·69466	0° 46
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

43 Deg. Departures, or Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
43° 0′	6·820	13·640	20·460	27·280	34·100	40·920	47·740	54·560	61·380	68·200	60′
5	6·831	13·661	20·492	27·322	34·153	40·984	47·814	54·645	61·476	68·306	55
10	6·841	13·682	20·524	27·365	34·206	41·047	47·889	54·730	61·571	68·412	50
15	6·852	13·704	20·555	27·407	34·259	41·111	47·963	54·815	61·666	68·518	45
20	6·862	13·725	20·587	27·450	34·312	41·174	48·037	54·899	61·762	68·624	40
25	6·873	13·746	20·619	27·492	34·365	41·238	48·111	54·984	61·857	68·730	35
30	6·883	13·767	20·651	27·534	34·418	41·301	48·185	55·068	61·952	68·835	30
35	6·894	13·788	20·682	27·576	34·470	41·364	48·259	55·153	62·047	68·941	25
40	6·905	13·809	20·714	27·618	34·523	41·428	48·332	55·237	62·141	69·046	20
45	6·915	13·830	20·745	27·660	34·576	41·491	48·406	55·321	62·236	69·151	15
50	6·926	13·851	20·777	27·702	34·628	41·554	48·479	55·405	62·331	69·256	10
55	6·936	13·872	20·808	27·744	34·681	41·617	48·553	55·489	62·425	69·361	5
60	6·947	13·893	20·840	27·786	34·733	41·680	48·626	55·573	62·519	69·466	46° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

46 Deg. Latitudes, or Horizontal Distances for Difference of Levels

TABLE II.

Latitudes, or Horizontal Distances for Difference of Levels

	Cosines	
44° 0′	·71934	60′
1	·71914	59
2	·71894	58
3	·71873	57
4	·71853	56
5	·71833	55
6	·71813	54
7	·71792	53
8	·71772	52
9	·71752	51
10	·71732	50
11	·71711	49
12	·71691	48
13	·71671	47
14	·71650	46
15	·71630	45
16	·71610	44
17	·71590	43
18	·71569	42
19	·71549	41
20	·71529	40
21	·71508	39
22	·71488	38
23	·71468	37
24	·71447	36
25	·71427	35
26	·71407	34
27	·71386	33
28	·71366	32
29	·71345	31
30	·71325	30
31	·71305	29
32	·71284	28
33	·71264	27
34	·71243	26
35	·71223	25
36	·71203	24
37	·71182	23
38	·71162	22
39	·71141	21
40	·71121	20
41	·71100	19
42	·71080	18
43	·71059	17
44	·71039	16
45	·71018	15
46	·70998	14
47	·70978	13
48	·70957	12
49	·70937	11
50	·70916	10
51	·70896	9
52	·70875	8
53	·70854	7
54	·70834	6
55	·70813	5
56	·70793	4
57	·70772	3
58	·70752	2
59	·70731	1
60	·70711	0°45
	Sines	

Departures, or Difference of Levels

44 Deg. Latitudes, or Horizontal Distances for Difference of Levels

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
44° 0′	7·193	14·387	21·580	28·774	35·967	43·160	50·354	57·547	64·741	71·934	60′
5	7·183	14·366	21·549	28·733	35·916	43·100	50·283	57·466	64·650	71·833	55
10	7·173	14·346	21·520	28·693	35·866	43·039	50·212	57·386	64·559	71·732	50
15	7·163	14·326	21·489	28·652	35·815	42·978	50·141	57·304	64·467	71·630	45
20	7·153	14·306	21·459	28·612	35·764	42·917	50·070	57·223	64·376	71·529	40
25	7·143	14·285	21·428	28·571	35·713	42·856	49·999	57·141	64·284	71·427	35
30	7·132	14·265	21·397	28·530	35·662	42·795	49·927	57·060	64·192	71·325	30
35	7·122	14·245	21·367	28·489	35·611	42·734	49·856	56·978	64·101	71·223	25
40	7·112	14·224	21·336	28·448	35·560	42·672	49·784	56·896	64·008	71·120	20
45	7·102	14·204	21·305	28·407	35·509	42·611	49·713	56·814	63·916	71·018	15
50	7·092	14·183	21·275	28·366	35·458	42·550	49·641	56·733	63·824	70·916	10
55	7·081	14·163	21·244	28·325	35·406	42·488	49·569	56·659	63·732	70·813	5
60	7·071	14·142	21·213	28·284	35·355	42·427	49·498	56·569	63·640	70·711	45° 0
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

DEPARTURES, OR DIFFERENCE OF LEVELS

45 Deg. Departures, or Difference of Levels

Departures, or Difference of Levels

	Sines	
44° 0′	·69466	60′
1	·69487	59
2	·69508	58
3	·69529	57
4	·69550	56
5	·69570	55
6	·69591	54
7	·69612	53
8	·69633	52
9	·69654	51
10	·69675	50
11	·69696	49
12	·69716	48
13	·69737	47
14	·69758	46
15	·69779	45
16	·69800	44
17	·69821	43
18	·69841	42
19	·69862	41
20	·69883	40
21	·69904	39
22	·69925	38
23	·69946	37
24	·69966	36
25	·69987	35
26	·70008	34
27	·70029	33
28	·70049	32
29	·70070	31
30	·70090	30
31	·70112	29
32	·70132	28
33	·70153	27
34	·70174	26
35	·70195	25
36	·70215	24
37	·70236	23
38	·70257	22
39	·70277	21
40	·70298	20
41	·70319	19
42	·70339	18
43	·70360	17
44	·70381	16
45	·70401	15
46	·70422	14
47	·70443	13
48	·70463	12
49	·70484	11
50	·70505	10
51	·70525	9
52	·70546	8
53	·70567	7
54	·70587	6
55	·70608	5
56	·70628	4
57	·70649	3
58	·70669	2
59	·70690	1
60	·70711	0°45
	Cosines	

Latitudes, or Horizontal Distances for Difference of Levels

DEPARTURES, OR DIFFERENCE OF LEVELS

44 Deg. Departures, or Difference of Levels

Measured Lengths	10	20	30	40	50	60	70	80	90	100	
44° 0′	6·947	13·893	20·840	27·786	34·733	41·680	48·626	55·573	62·519	69·466	60′
5	6·957	13·914	20·871	27·828	34·785	41·742	48·699	55·656	62·613	69·570	55
10	6·967	13·935	20·902	27·870	34·837	41·805	48·772	55·740	62·707	69·675	50
15	6·978	13·966	20·934	27·912	34·889	41·867	48·845	55·823	62·801	69·779	45
20	6·988	13·977	20·965	27·953	34·941	41·930	48·918	55·906	62·895	69·883	40
25	6·999	13·997	20·996	27·995	34·993	41·992	48·991	56·000	62·988	69·987	35
30	7·009	14·018	21·027	28·036	35·045	42·055	49·064	56·073	63·082	70·091	30
35	7·019	14·039	21·058	28·078	35·097	42·116	49·136	56·155	63·175	70·194	25
40	7·030	14·060	21·089	28·119	35·149	42·179	49·209	56·238	63·268	70·298	20
45	7·040	14·080	21·120	28·160	35·200	42·241	49·281	56·321	63·361	70·401	15
50	7·050	14·101	21·151	28·202	35·252	42·303	49·353	56·404	63·454	70·505	10
55	7·061	14·122	21·182	28·243	35·304	42·365	49·426	56·486	63·547	70·608	5
60	7·071	14·142	21·213	28·284	35·355	42·426	49·497	56·568	63·640	70·711	0 45°
	10	20	30	40	50	60	70	80	90	100	Measured Lengths

LATITUDES, OR HORIZONTAL DISTANCES FOR DIFFERENCE OF LEVELS

45 Deg. Latitudes, or Horizontal Distances for Difference of Levels

TABLE III.

0 DEGREE

0°	Tangent	Cotangent	
0′	·00000	Infinite	60′
1	·00029	3437·7460	59
2	·00058	718·8730	58
3	·00087	145·9150	57
4	·00116	859·4363	56
5	·00145	687·4588	55
6	·00175	572·9572	54
7	·00204	491·1060	53
8	·00233	429·7175	52
9	·00262	381·9709	51
10	·00291	343·7737	50
11	·00320	312·5213	49
12	·00349	286·4777	48
13	·00378	264·4408	47
14	·00407	245·5519	46
15	·00436	229·1816	45
16	·00465	214·8576	44
17	·00495	202·2187	43
18	·00524	190·9841	42
19	·00553	180·9322	41
20	·00582	171·8854	40
21	·00611	163·7001	39
22	·00640	156·2590	38
23	·00669	149·4650	37
24	·00698	143·2371	36
25	·00727	137·5075	35
26	·00756	132·2185	34
27	·00785	127·3213	33
28	·00814	122·7739	32
29	·00844	118·5401	31
30	·00873	114·5886	30
31	·00902	110·8920	29
32	·00931	107·4264	28
33	·00960	104·1709	27
34	·00989	101·1069	26
35	·01018	98·2179	25
36	·01047	95·4894	24
37	·01076	92·9084	23
38	·01105	90·4633	22
39	·01135	88·1435	21
40	·01164	85·8397	20
41	·01193	83.8435	19
42	·01222	81·8470	18
43	·01251	79·9434	17
44	·01280	78·1263	16
45	·01309	76·3900	15
46	·01338	74·7291	14
47	·01367	73·1389	13
48	·01396	71·6150	12
49	·01425	70·1533	11
50	·01455	68·7500	10
51	·01484	67·4018	9
52	·01513	66·1054	8
53	·01542	64·8580	7
54	·01571	63·6567	6
55	·01600	62·4991	5
56	·01629	61·3829	4
57	·01658	60·3058	3
58	·01687	59·2658	2
59	·01716	58·2611	1
60	·01746	57·2899	89° 0
	Cotangent	Tangent	

89 DEGREES

TANGENTIAL ANGLES FOR CIRCULAR CURVES.

400 feet
4 chains } Radii.
40 mêtres

BENDS.

In one 66 feet chain $6\frac{1}{8}$ inches
Rails 18 „ lengths $1\frac{3}{8}$ „
In one 100 „ chain $9\frac{3}{8}$ „
Rails 18 „ lengths $1\frac{3}{16}$ „

SUPERELEVATION OF RAILS.

66 feet chain, 20 m. per hour 6″
100 feet chain, 20 m. per hour $3\frac{1}{2}$″

Left-hand Reading		No. of Chains	Right-hand Reading	
356°	25·1′	$\frac{1}{2}$	3°	34·8′
352	50·3	1	7	9·7
349	15·4	$1\frac{1}{2}$	10	44·6
345	40·5	2	14	19·4
342	5·7	$2\frac{1}{2}$	17	54·3
338	30·8	3	21	29·1
334	56·0	$3\frac{1}{2}$	25	4·0
331	21·1	4	28	38·9
327	46·3	$4\frac{1}{2}$	32	13·7
324	11·4	5	35	48·6
320	36·5	$5\frac{1}{2}$	39	23·4
317	1·7	6	42	58·3
313	26·8	$6\frac{1}{2}$	46	33·2
309	52·0	7	50	8·0
306	17·1	$7\frac{1}{2}$	53	42·9
302	42·2	8	57	17·7
299	7·4	$8\frac{1}{2}$	60	52·6
295	32·5	9	64	27·5
291	57·7	$9\frac{1}{2}$	68	2·3
288	22·8	10	71	37·2
284	47·9	$10\frac{1}{2}$	75	12·0
281	13·1	11	78	46·9
277	38·2	$11\frac{1}{2}$	82	21·7
274	3·4	12	85	56·6
270	28·5	$12\frac{1}{2}$	89	31·5

1 DEGREE

	Tangent	Cotangent	
1° 0′	·01746	57·2899	60′
1	·01775	56·3505	59
2	·01804	55·4415	58
3	·01833	54·5613	57
4	·01862	53·7085	56
5	·01891	52·8821	55
6	·01920	52·0806	54
7	·01949	51·3031	53
8	·01978	50·5485	52
9	·02007	49·8157	51
10	·02037	49·1038	50
11	·02056	48·4120	49
12	·02095	47·7395	48
13	·02123	47·0853	47
14	·02153	46·4488	46
15	·02182	45·8293	45
16	·02211	45·2261	44
17	·02240	44·6385	43
18	·02269	44·0661	42
19	·02298	43·5081	41
20	·02328	42·9640	40
21	·02357	42·4334	39
22	·02386	41·9157	38
23	·02415	41·4105	37
24	·02444	40·9174	36
25	·02473	40·4358	35
26	·02502	39·9654	34
27	·02531	39·5058	33
28	·02560	39·0567	32
29	·02589	38·6177	31
30	·02619	38·1884	30
31	·02648	37·7686	29
32	·02677	37·3578	28
33	·02706	36·9560	27
34	·02735	36·5626	26
35	·02764	36·1775	25
36	·02793	35·8005	24
37	·02822	35·4312	23
38	·02851	35·0695	22
39	·02881	34·7151	21
40	·02910	34·3677	20
41	·02939	34·0273	19
42	·02968	33·6935	18
43	·02997	33·3661	17
44	·03026	33·0451	16
45	·03055	32·7302	15
46	·03084	32·4212	14
47	·03114	32·1180	13
48	·03143	31·8205	12
49	·03172	31·5283	11
50	·03201	31·2415	10
51	·03230	30·9599	9
52	·03259	30·6833	8
53	·03288	30·4115	7
54	·03317	30·1446	6
55	·03346	29·8822	5
56	·03376	29·6244	4
57	·03405	29·3711	3
58	·03434	29·1220	2
59	·03463	28·8770	1
60	·03492	28·6362	88° 0
	Cotangent	Tangent	

88 DEGREES

TANGENTIAL ANGLES FOR CIRCULAR CURVES.

500 feet }
5 chains } Radii.
50 mêtres }

BENDS.

In one 66 feet chain 5 inches
Rails 18 „ lengths 1⅜ „
In one 100 „ chain 7½ „
Rails 18 „ lengths 1 „

SUPERELEVATION OF RAILS.

66 feet chain, 20 m. per hour 4½″
100 feet chain, 20 m. per hour 3″

Left-hand Reading	No. of Chains	Right-hand Reading
357° 8·1′	½	2° 51·9′
354 16·2	1	5 43·7
351 24·4	1½	8 35·6
348 32·5	2	11 27·5
345 40·6	2½	14 19·4
342 48·7	3	17 11·3
339 56·8	3½	20 3·1
337 5·0	4	22 55·0
334 13·0	4½	25 46·9
331 21·2	5	28 38·8
328 29·3	5½	31 30·6
325 37·4	6	34 22·5
322 45·6	6½	37 14·4
319 53·7	7	40 6·3
317 1·8	7½	42 58·2
314 9·9	8	45 50·1
311 18·1	8½	48 41·9
308 26·2	9	51 33·8
305 34·3	9½	54 25·7
302 42·4	10	57 17·6
299 50·5	10½	60 9·4
296 58·7	11	63 1·3
294 6·8	11½	65 53·2
291 14·9	12	68 45·1
288 23·0	12½	71 36·9

TABLE III.

2 DEGREES

	Tangent	Cotangent	
2° 0′	·03492	28·6362	60′
1	·03521	28·3993	59
2	·03550	28·1664	58
3	·03579	27·9372	57
4	·03609	27·7117	56
5	·03638	27·4898	55
6	·03667	27·2714	54
7	·03696	27·0565	53
8	·03725	26·8449	52
9	·03754	26·6366	51
10	·03783	26·4316	50
11	·03812	26·2296	49
12	·03842	26·0307	48
13	·03871	25·8348	47
14	·03900	25·6418	46
15	·03929	25·4517	45
16	·03958	25·2643	44
17	·03987	25·0797	43
18	·04016	24·8978	42
19	·04046	24·7185	41
20	·04075	24·5417	40
21	·04104	24·3675	39
22	·04133	24·1957	38
23	·04162	24·0263	37
24	·04191	23·8592	36
25	·04220	23·6945	35
26	·04250	23·5320	34
27	·04279	23·3717	33
28	·04308	23·2136	32
29	·04337	23·0576	31
30	·04366	22·9037	30
31	·04395	22·7518	29
32	·04424	22·6020	28
33	·04454	22·4540	27
34	·04483	22·3080	26
35	·04512	22·1639	25
36	·04541	22·0217	24
37	·04570	21·8812	23
38	·04599	21·7425	22
39	·04628	21·6056	21
40	·04658	21·4704	20
41	·04687	21·3368	19
42	·04716	21·2049	18
43	·04745	21·0746	17
44	·04774	20·9459	16
45	·04803	20·8118	15
46	·04833	20·6932	14
47	·04862	20·5691	13
48	·04891	20·4464	12
49	·04920	20·3253	11
50	·04949	20·2055	10
51	·04978	20·0871	9
52	·05007	19·9702	8
53	·05037	19·8545	7
54	·05066	19·7402	6
55	·05095	19·6272	5
56	·05124	19·5155	4
57	·05153	19·4051	3
58	·05182	19·2959	2
59	·05212	19·1879	1
60	·05241	19·0811	87° 0
	Cotangent	Tangent	

87 DEGREES

TANGENTIAL ANGLES FOR CIRCULAR CURVES.

600 feet
6 chains } Radii.
60 mêtres

BENDS.

In one 66 feet chain $4\frac{1}{8}$ inches
Rails 18 „ lengths 1 „
In one 100 „ chain $6\frac{3}{8}$ „
Rails 18 „ lengths $\frac{13}{16}$ „

SUPERELEVATION OF RAILS.

66 feet chain, 20 m. per hour $3\frac{3}{4}$″
100 feet chain, 25 m. per hour 4″

Left-hand Reading		No. of Chains	Right-hand Reading	
357°	36·8′	$\frac{1}{2}$	2°	23·2′
355	13·5	1	4	46·5
352	50·3	$1\frac{1}{2}$	7	9·7
350	27·0	2	9	32·9
348	3·8	$2\frac{1}{2}$	11	56·2
345	40·6	3	14	19·4
343	17·3	$3\frac{1}{2}$	16	42·7
340	54·1	4	19	5·9
338	30·8	$4\frac{1}{2}$	21	29·1
336	7·6	5	23	52·4
333	44·4	$5\frac{1}{2}$	26	15·6
331	21·1	6	28	38·9
328	57·9	$6\frac{1}{2}$	31	2·1
326	34·6	7	33	25·3
324	11·4	$7\frac{1}{2}$	35	48·6
321	48·2	8	38	11·8
319	24·9	$8\frac{1}{2}$	40	35·1
317	1·7	9	42	58·3
314	38·4	$9\frac{1}{2}$	45	21·5
312	15·2	10	47	44·8
309	52·0	$10\frac{1}{2}$	50	8·0
307	28·7	11	52	31·3
305	5·5	$11\frac{1}{2}$	54	54·5
302	42·2	12	57	17·7
300	19·0	$12\frac{1}{2}$	59	41·0

3 DEGREES

	Tangent	Cotangent	
3° 0′	·05241	19·0811	60′
1	·05270	18·9755	59
2	·05299	18·8710	58
3	·05328	18·7677	57
4	·05357	18·6655	56
5	·05387	18·5644	55
6	·05416	18·4644	54
7	·05445	18·3655	53
8	·05474	18·2676	52
9	·05503	18·1708	51
10	·05533	18·0749	50
11	·05562	17·9801	49
12	·05591	17·8863	48
13	·05620	17·7934	47
14	·05649	17·7015	46
15	·05678	17·6105	45
16	·05708	17·5205	44
17	·05737	17·4313	43
18	·05766	17·3431	42
19	·05795	17·2558	41
20	·05824	17·1693	40
21	·05853	17·0837	39
22	·05883	16·9989	38
23	·05912	16·9150	37
24	·05941	16·8319	36
25	·05970	16·7496	35
26	·05999	16·6681	34
27	·06029	16·5873	33
28	·06058	16·5074	32
29	·06087	16·4282	31
30	·06116	16·3498	30
31	·06145	16·2721	29
32	·06175	16·1952	28
33	·06204	16·1189	27
34	·06233	16·0434	26
35	·06262	15·9686	25
36	·06291	15·8945	24
37	·06321	15·8211	23
38	·06350	15·7483	22
39	·06379	15·6762	21
40	·06408	15·6047	20
41	·06438	15·5339	19
42	·06467	15·4638	18
43	·06496	15·3942	17
44	·06525	15·3253	16
45	·06554	15·2570	15
46	·06584	15·1893	14
47	·06613	15·1222	13
48	·06642	15·0557	12
49	·06671	14·9897	11
50	·06700	14·9244	10
51	·06730	14·8596	9
52	·06759	14·7953	8
53	·06788	14·7316	7
54	·06817	14·6685	6
55	·06847	14·6059	5
56	·06876	14·5438	4
57	·06905	14·4822	3
58	·06934	14·4212	2
59	·06963	14·3606	1
60	·06993	14·3006	86° 0
	Cotangent	Tangent	

86 DEGREES

TANGENTIAL ANGLES FOR CIRCULAR CURVES.

700 feet
7 chains } Radii.
70 mêtres

BENDS.

In one 66 feet chain 3½ inches
Rails 18 „ lengths ⅞ „
In one 100 „ chain 5⅜ „
Rails 18 „ lengths 11/16 „

SUPERELEVATION OF RAILS.

66 feet chain, 20 m. per hour 3¼″
100 feet chain, 25 m. per hour 3¼″

Left-hand Reading		No. of Chains	Right-hand Reading	
357°	57·2′	½	2°	2·8′
355	54·4	1	4	5·5
353	51·7	1½	6	8·3
351	48·9	2	8	11·1
349	46·1	2½	10	13·8
347	43·4	3	12	16·6
345	40·6	3½	14	19·4
343	37·8	4	16	22·2
341	35·0	4½	18	24·9
339	32·3	5	20	27·7
337	29·5	5½	22	30·5
335	26·7	6	24	33·3
333	24·0	6½	26	36·0
331	21·2	7	28	38·8
329	18·4	7½	30	41·6
327	15·6	8	32	44·3
325	12·9	8½	34	47·1
323	10·1	9	36	49·9
321	7·3	9½	38	52·7
319	4·5	10	40	55·4
317	1·8	10½	42	58·2
314	59·0	11	45	1·0
312	56·2	11½	47	3·7
310	53·5	12	49	6·5
308	50·7	12½	51	9·3

4 Degrees

	Tangent	Cotangent	
4° 0′	·06993	14·3006	60′
1	·07022	14·2411	59
2	·07051	14·1820	58
3	·07080	14·1235	57
4	·07110	14·0654	56
5	·07139	14·0078	55
6	·07168	13·9507	54
7	·07197	13·8940	53
8	·07227	13·8378	52
9	·07256	13·7820	51
10	·07285	13·7267	50
11	·07314	13·6718	49
12	·07343	13·6174	48
13	·07373	13·5633	47
14	·07402	13·5097	46
15	·07431	13·4566	45
16	·07461	13·4038	44
17	·07490	13·3515	43
18	·07519	13·2995	42
19	·07548	13·2480	41
20	·07578	13·1968	40
21	·07607	13·1461	39
22	·07636	13·0957	38
23	·07665	13·0457	37
24	·07695	12·9961	36
25	·07724	12·9469	35
26	·07753	12·8980	34
27	·07782	12·8495	33
28	·07812	12·8014	32
29	·07841	12·7536	31
30	·07870	12·7062	30
31	·07899	12·6591	29
32	·07929	12·6123	28
33	·07958	12·5659	27
34	·07987	12·5199	26
35	·08017	12·4742	25
36	·08046	12·4288	24
37	·08075	12·3837	23
38	·08104	12·3390	22
39	·08134	12·2946	21
40	·08163	12·2505	20
41	·08192	12·2067	19
42	·08222	12·1632	18
43	·08251	12·1200	17
44	·08280	12·0771	16
45	·08309	12·0346	15
46	·08339	11·9923	14
47	·08368	11·9503	13
48	·08397	11·9086	12
49	·08427	11·8672	11
50	·08456	11·8261	10
51	·08485	11·7853	9
52	·08514	11·7447	8
53	·08544	11·7045	7
54	·08573	11·6644	6
55	·08602	11·6247	5
56	·08632	11·5852	4
57	·08661	11·5460	3
58	·08690	11·5071	2
59	·08720	11·4684	1
60	·08749	11·4300	85° 0
	Cotangent	Tangent	

85 Degrees

TANGENTIAL ANGLES FOR CIRCULAR CURVES.

800 feet
8 chains } Radii.
80 mêtres

Bends.

In one 66 feet chain 3⅛ inches
Rails 18 „ lengths 6/8 „
In one 100 „ chain 4¾ „
Rails 18 „ lengths 9/16 „

Superelevation of Rails.

66 feet chain, 25 m. per hour 4½″
100 feet chain, 25 m. per hour 3″

Left-hand Reading	No. of Chains	Right-hand Reading
358° 12·6′	½	1° 47·4′
356 25·1	1	3 34·8
354 37·7	1½	5 22·3
352 50·3	2	7 9·7
351 2·8	2½	8 57·1
349 15·4	3	10 44·6
347 28·0	3½	12 32·0
345 4·5	4	14 19·4
343 53·1	4½	16 6·8
342 5·7	5	17 54·3
340 18·3	5½	19 41·7
338 30·8	6	21 29·1
336 43·4	6½	23 16·6
334 56·0	7	25 4·0
333 8·5	7½	26 51·4
331 21·1	8	28 38·9
329 33·7	8½	30 26·3
327 46·3	9	32 13·7
325 58·8	9½	34 1·2
324 11·4	10	35 48·6
322 24·0	10½	37 36·0
320 36·5	11	39 23·4
318 49·1	11½	41 10·9
317 1·7	12	42 58·3
315 14·2	12½	44 45·7

5 Degrees

	Tangent	Cotangent	
5° 0′	·08749	11·4300	60′
1	·08778	11·3918	59
2	·08807	11·3539	58
3	·08837	11·3163	57
4	·08866	11·2788	56
5	·08895	11·2471	55
6	·08925	11·2047	54
7	·08954	11·1680	53
8	·08983	11·1316	52
9	·09013	11·0954	51
10	·09042	11·0594	50
11	·09071	11·0236	49
12	·09101	10·9881	48
13	·09130	10·9528	47
14	·09159	10·9177	46
15	·09189	10·8829	45
16	·09218	10·8482	44
17	·09247	10·8138	43
18	·09277	10·7796	42
19	·09306	10·7456	41
20	·09335	10·7119	40
21	·09365	10·6783	39
22	·09394	10·6449	38
23	·09423	10·6118	37
24	·09453	10·5788	36
25	·09482	10·5461	35
26	·09511	10·5136	34
27	·09541	10·4812	33
28	·09570	10·4491	32
29	·09600	10·4171	31
30	·09629	10·3853	30
31	·09658	10·3538	29
32	·09688	10·3224	28
33	·09717	10·2912	27
34	·09746	10·2602	26
35	·09776	10·2294	25
36	·09805	10·1987	24
37	·09834	10·1683	23
38	·09864	10·1380	22
39	·09893	10·1079	21
40	·09923	10·0780	20
41	·09952	10·0482	19
42	·09981	0·0187	18
43	·10011	9·9893	17
44	·10040	9·9600	16
45	·10069	9·9310	15
46	·10099	9·9021	14
47	·10128	9·8733	13
48	·10158	9·8448	12
49	·10187	9·8164	11
50	·10216	9·7881	10
51	·10245	9·7600	9
52	·10275	9·7321	8
53	·10305	9·7044	7
54	·10334	9·6768	6
55	·10363	9·6493	5
56	·10393	9·6220	4
57	·10422	9·5949	3
58	·10452	9·5679	2
59	·10481	9·5410	1
60	·10510	9·5143	84° 0
	Cotangent	Tangent	

84 Degrees

TANGENTIAL ANGLES FOR CIRCULAR CURVES.

900 feet
9 chains Radii.
90 mêtres

Bends.

In one 66 feet chain $2\frac{3}{4}$ inches
Rails 18 „ lengths $\frac{11}{16}$ „
In one 100 „ chain $4\frac{1}{8}$ „
Rails 18 „ lengths $\frac{17}{32}$ „

Superelevation of Rails.

66 feet chain, 25 m. per hour 4″
100 feet chain, 35 m. per hour 5″

Left-hand Reading	No. of Chains	Right-hand Reading
358° 24·5′	$\frac{1}{2}$	1° 35·5′
356 49·0	1	3 11·0
355 13·5	$1\frac{1}{2}$	4 46·5
353 38·0	2	6 22·0
352 2·5	$2\frac{1}{2}$	7 57·5
350 27·0	3	9 33·0
348 51·5	$3\frac{1}{2}$	11 8·4
347 16·0	4	12 43·9
345 40·5	$4\frac{1}{2}$	14 19·4
344 5·1	5	15 54·9
342 29·6	$5\frac{1}{2}$	17 30·4
340 54·1	6	19 5·9
339 18·6	$6\frac{1}{2}$	20 41·4
337 43·1	7	22 16·9
336 7·6	$7\frac{1}{2}$	23 52·4
334 32·1	8	25 27·9
332 56·6	$8\frac{1}{2}$	27 3·4
331 21·1	9	28 38·9
329 45·6	$9\frac{1}{2}$	30 14·4
328 10·1	10	31 49·8
326 34·6	$10\frac{1}{2}$	33 25·3
324 59·1	11	35 0·8
323 23·7	$11\frac{1}{2}$	36 36·3
321 48·2	12	38 11·8
320 12·7	$12\frac{1}{2}$	39 47·3

6 DEGREES

	Tangent	Cotangent	
6° 0′	·10510	9·5143	60′
1	·10540	9·4878	59
2	·10569	9·4614	58
3	·10599	9·4351	57
4	·10628	9·4090	56
5	·10658	9·3830	55
6	·10687	9·3572	54
7	·10716	9·3315	53
8	·10746	9·3059	52
9	·10775	9·2805	51
10	·10805	9·2553	50
11	·10834	9·2301	49
12	·10863	9·2051	48
13	·10893	9·1802	47
14	·10922	9·1555	46
15	·10952	9·1309	45
16	·10981	9·1064	44
17	·11011	9·0821	43
18	·11040	9·0578	42
19	·11070	9·0337	41
20	·11099	9·0098	40
21	·11128	8·9859	39
22	·11158	8·9622	38
23	·11187	8·9386	37
24	·11217	8·9152	36
25	·11246	8·8918	35
26	·11276	8·8686	34
27	·11305	8·8455	33
28	·11335	8·8225	32
29	·11364	8·7996	31
30	·11394	8·7768	30
31	·11423	8·7542	29
32	·11453	8·7317	28
33	·11482	8·7093	27
34	·11511	8·6870	26
35	·11541	8·6648	25
36	·11570	8·6427	24
37	·11600	8·6207	23
38	·11629	8·5989	22
39	·11659	8·5771	21
40	·11688	8·5555	20
41	·11718	8·5340	19
42	·11747	8·5125	18
43	·11777	8·4912	17
44	·11806	8·4700	16
45	·11836	8·4489	15
46	·11865	8·4279	14
47	·11895	8·4070	13
48	·11924	8·3862	12
49	·11954	8·3655	11
50	·11983	8·3449	10
51	·12013	8·3244	9
52	·12042	8·3040	8
53	·12072	8·2837	7
54	·12101	8·2635	6
55	·12131	8·2434	5
56	·12160	8·2234	4
57	·12190	8·2035	3
58	·12219	8·1837	2
59	·12249	8·1639	1
60	·12278	8·1443	83° 0
	Cotangent	Tangent	

83 DEGREES

TANGENTIAL ANGLES FOR CIRCULAR CURVES.

1000 feet }
10 chains } Radii.
100 mêtres }

BENDS.

In one 66 feet chain $2\frac{3}{8}$ inches
Rails 18 „ lengths $\frac{13}{32}$ „
In one 100 „ chain $3\frac{3}{8}$ „
Rails 18 „ lengths $\frac{1}{2}$ „

SUPERELEVATION OF RAILS.

66 feet chain, 30 m. per hour $5\frac{1}{8}$″
100 feet chain, 35 m. per hour $4\frac{1}{2}$″

Left-hand Reading	No. of Chains	Right-hand Reading
358° 34·1′	½	1° 25·9′
357 8·1	1	2 51·9
355 42·2	1½	4 17·8
354 16·2	2	5 43·8
352 50·3	2½	7 9·7
351 24·3	3	8 35·7
349 58·4	3½	10 1·6
348 32·4	4	11 27·5
347 6·5	4½	12 53·5
345 40·6	5	14 19·4
344 14·6	5½	15 45·4
342 49·7	6	17 11·3
341 22·7	6½	18 37·3
339 56·8	7	20 3·2
338 30·8	7½	21 29·1
337 4·9	8	22 55·1
335 38·9	8½	24 21·0
334 13·0	9	25 47·0
332 47·1	9½	27 13·0
331 21·1	10	28 38·9
329 55·2	10½	30 4·8
328 29·2	11	31 30·8
327 3·3	11½	32 56·7
325 37·3	12	34 22·6
324 11·4	12½	35 48·6

7 Degrees

	Tangent	Cotangent	
7° 0′	·12278	8·1443	60′
1	·12308	8·1248	59
2	·12338	8·1053	58
3	·12367	8·0860	57
4	·12397	8·0667	56
5	·12426	8·0475	55
6	·12456	8·0284	54
7	·12485	8·0094	53
8	·12515	7·9905	52
9	·12544	7·9717	51
10	·12574	7·9530	50
11	·12603	7·9343	49
12	·12633	7·9158	48
13	·12662	7·8973	47
14	·12692	7·8789	46
15	·12722	7·8606	45
16	·12751	7·8424	44
17	·12781	7·8242	43
18	·12810	7·8062	42
19	·12840	7·7882	41
20	·12869	7·7703	40
21	·12899	7·7525	39
22	·12929	7·7348	38
23	·12958	7·7171	37
24	·12988	7·6995	36
25	·13017	7·6820	35
26	·13047	7·6646	34
27	·13076	7·6473	33
28	·13106	7·6300	32
29	·13136	7·6128	31
30	·13165	7·5957	30
31	·13195	7·5787	29
32	·13224	7·5617	28
33	·13254	7·5448	27
34	·13284	7·5280	26
35	·13313	7·5113	25
36	·13343	7·4946	24
37	·13372	7·4780	23
38	·13402	7·4615	22
39	·13432	7·4450	21
40	·13461	7·4287	20
41	·13491	7·4123	19
42	·13521	7·3961	18
43	·13550	7·3799	17
44	·13580	7·3638	16
45	·13609	7·3478	15
46	·13639	7·3318	14
47	·13669	7·3160	13
48	·13698	7·3001	12
49	·13728	7·2844	11
50	·13758	7·2687	10
51	·13787	7·2530	9
52	·13817	7·2375	8
53	·13847	7·2220	7
54	·13876	7·2066	6
55	·13906	7·1912	5
56	·13935	7·1759	4
57	·13965	7·1607	3
58	·13995	7·1455	2
59	·14024	7·1304	1
60	·14054	7·1153	82° 0
	Cotangent	Tangent	

82 Degrees

TANGENTIAL ANGLES FOR CIRCULAR CURVES.

1500 feet }
15 chains } Radii.
150 mêtres }

Bends.

In ½ 66 feet chain $1\frac{5}{8}$ inches
Rails 18 „ lengths $\frac{7}{16}$ „
In ½ 100 „ chain 2½ „
Rails 18 „ lengths $\frac{9}{32}$ „

Superelevation of Rails.

66 feet chain, 35 m. per hour 4½″
100 feet chain, 35 m. per hour $3\frac{1}{8}$″

Left-hand Reading	No. of Chains	Right-hand Reading
359° 2·7′	½	0° 57·3′
358 5·4	1	1 54·6
357 8·1	1½	2 51·9
356 10·8	2	3 49·2
355 13·5	2½	4 46·5
354 16·2	3	5 43·8
353 18·9	3½	6 41·1
352 21·6	4	7 38·4
351 24·3	4½	8 35·6
350 27·0	5	9 32·9
349 29·7	5½	10 30·2
348 32·4	6	11 27·5
347 35·1	6½	12 24·8
346 37·8	7	13 22·1
345 40·6	7½	14 19·4
344 43·2	8	15 16·7
343 46·0	8½	16 14·0
342 48·7	9	17 11·3
341 51·4	9½	18 8·6
340 54·1	10	19 5·9
339 56·8	10½	20 3·2
338 59·5	11	21 0·5
338 2·2	11½	21 57·8
337 4·9	12	22 55·1
336 7·6	12½	23 52·4

8 DEGREES

	Tangent	Cotangent	
8° 0′	·14054	7·1153	60′
1	·14084	7·1003	59
2	·14113	7·0854	58
3	·14143	7·0705	57
4	·14173	7·0557	56
5	·14202	7·0410	55
6	·14232	7·0263	54
7	·14262	7·0117	53
8	·14291	6·9971	52
9	·14321	6·9826	51
10	·14351	6·9682	50
11	·14381	6·9538	49
12	·14410	6·9395	48
13	·14440	6·9252	47
14	·14470	6·9110	46
15	·14499	6·8968	45
16	·14529	6·8827	44
17	·14559	6·8687	43
18	·14588	6·8547	42
19	·14618	6·8408	41
20	·14648	6·8269	40
21	·14677	6·8131	39
22	·14707	6·7993	38
23	·14737	6·7856	37
24	·14767	6·7719	36
25	·14796	6·7583	35
26	·14826	6·7448	34
27	·14856	6·7313	33
28	·14886	6·7178	32
29	·14915	6·7044	31
30	·14945	6·6911	30
31	·14975	6·6778	29
32	·15005	6·6646	28
33	·15034	6·6514	27
34	·15064	6·6383	26
35	·15094	6·6252	25
36	·15123	6·6121	24
37	·15153	6·5992	23
38	·15183	6·5862	22
39	·15213	6·5733	21
40	·15243	6·5605	20
41	·15272	6·5477	19
42	·15302	6·5350	18
43	·15332	6·5223	17
44	·15362	6·5096	16
45	·15391	6·4971	15
46	·15421	6·4845	14
47	·15451	6·4720	13
48	·15481	6·4596	12
49	·15511	6·4472	11
50	·15540	6·4348	10
51	·15570	6·4225	9
52	·15600	6·4102	8
53	·15630	6·3980	7
54	·15660	6·3858	6
55	·15689	6·3737	5
56	·15719	6·3616	4
57	·15749	6·3496	3
58	·15779	6·3376	2
59	·15808	6·3256	1
60	·15838	6·3137	81° 0
	Cotangent	Tangent	

81 DEGREES

TANGENTIAL ANGLES FOR CIRCULAR CURVES.

2000 feet
20 chains } Radii.
200 mêtres

BENDS.

In one 66 feet chain 5 inches
Rails 18 „ lengths $\frac{5}{16}$ „
In one 100 „ chain $7\frac{1}{2}$ „
Rails 18 „ lengths $\frac{1}{4}$ „

SUPERELEVATION OF RAILS.

66 feet chain, 35 m. per hour $2\frac{7}{8}''$
100 feet chain, 35 m. per hour $2\frac{3}{8}''$

Left-hand Reading	No. of Chains	Right-hand Reading
358° 34·1′	1	1° 25·9′
357 8·1	2	2 51·9
355 42·2	3	4 17·8
354 16·2	4	5 43·8
352 50·3	5	7 9·7
351 24·3	6	8 35·6
349 58·4	7	10 1·6
348 32·4	8	11 27·5
347 6·5	9	12 53·5
345 40·6	10	14 19·4
344 14·6	11	15 45·4
342 48·7	12	17 11·3
341 22·7	13	18 37·2
339 56·8	14	20 3·2
338 30·8	15	21 29·1
337 4·9	16	22 55·1
335 38·9	17	24 21·0
334 13·0	18	25 47·0
332 47·1	19	27 12·9
331 21·1	20	28 38·9
329 55·2	21	30 4·8
328 29·2	22	31 30·7
327 3·3	23	32 56·7
325 37·3	24	34 22·6
324 11·4	25	35 48·6

9 Degrees

	Tangent	Cotangent	
9° 0′	·15838	6·3137	60′
1	·15868	6·3018	59
2	·15898	6·2900	58
3	·15928	6·2782	57
4	·15958	6·2665	56
5	·15988	6·2548	55
6	·16017	6·2432	54
7	·16047	6·2316	53
8	·16077	6·2200	52
9	·16107	6·2085	51
10	·16137	6·1970	50
11	·16167	6·1855	49
12	·16196	6·1741	48
13	·16226	6·1628	47
14	·16256	6·1515	46
15	·16286	6·1402	45
16	·16316	6·1289	44
17	·16346	6·1177	43
18	·16376	6·1066	42
19	·16406	6·0955	41
20	·16435	6·0844	40
21	·16465	6·0733	39
22	·16495	6·0623	38
23	·16525	6·0514	37
24	·16555	6·0405	36
25	·16585	6·0296	35
26	·16615	6·0187	34
27	·16645	6·0079	33
28	·16674	5·9971	32
29	·16704	5·9864	31
30	·16734	5·9757	30
31	·16764	5·9651	29
32	·16794	5·9544	28
33	·16824	5·9438	27
34	·16854	5·9333	26
35	·16884	5·9228	25
36	·16914	5·9123	24
37	·16944	5·9019	23
38	·16974	5·8915	22
39	·17004	5·8811	21
40	·17033	5·8708	20
41	·17063	5·8605	19
42	·17093	5·8502	18
43	·17123	5·8400	17
44	·17153	5·8298	16
45	·17183	5·8196	15
46	·17213	5·8095	14
47	·17243	5·7994	13
48	·17273	5·7893	12
49	·17303	5·7793	11
50	·17333	5·7693	10
51	·17363	5·7594	9
52	·17393	5·7494	8
53	·17423	5·7395	7
54	·17453	5·7297	6
55	·17483	5·7199	5
56	·17513	5·7101	4
57	·17543	5·7003	3
58	·17573	5·6906	2
59	·17603	5·6809	1
60	·17633	5·6712	80° 0
	Cotangent	Tangent	

80 Degrees

TANGENTIAL ANGLES FOR CIRCULAR CURVES.

2500 feet
25 chains } Radii.
250 mêtres

Bends.

In one 66 feet chain 4 inches
Rails 18 „ lengths $\frac{3}{32}$ „
In one 100 „ chain 6 „
Rails 18 „ lengths $\frac{3}{16}$ „

Superelevation of Rails.

66 feet chain, 35 m. per hour $2\frac{7}{8}''$
100 feet chain, 45 m. per hour 3″

Left-hand Reading	No. of Chains	Right-hand Reading
358° 51·2′	1	1° 8·7′
357 42·5	2	2 17·5
356 33·7	3	3 26·2
355 25·0	4	4 35·0
354 16·2	5	5 43·7
353 7·5	6	6 52·5
351 58·7	7	8 1·3
350 50·0	8	9 10·0
349 41·2	9	10 18·8
348 32·5	10	11 27·5
347 23·7	11	12 36·3
346 15·0	12	13 45·0
345 6·2	13	14 53·8
343 57·5	14	16 2·5
342 48·7	15	17 11·3
341 40·0	16	18 20·0
340 31·2	17	19 28·8
339 22·5	18	20 37·5
338 13·7	19	21 46·3
337 5·0	20	22 55·0
335 56·2	21	24 3·8
334 47·5	22	25 12·5
333 38·7	23	26 21·3
332 30·0	24	27 30·0
331 21·2	25	28 38·8

10 DEGREES

	Tangent	Cotangent	
10° 0′	·17633	5·6712	60′
1	·17663	5·6616	59
2	·17693	5·6520	58
3	·17723	5·6424	57
4	·17753	5·6329	56
5	·17783	5·6234	55
6	·17813	5·6139	54
7	·17843	5·6045	53
8	·17873	5·5951	52
9	·17903	5·5857	51
10	·17933	5·5763	50
11	·17963	5·5670	49
12	·17993	5·5577	48
13	·18023	5·5485	47
14	·18053	5·5392	46
15	·18083	5·5300	45
16	·18113	5·5209	44
17	·18143	5·5117	43
18	·18173	5·5026	42
19	·18203	5·4935	41
20	·18233	5·4845	40
21	·18263	5·4754	39
22	·18293	5·4664	38
23	·18323	5·4575	37
24	·18353	5·4485	36
25	·18383	5·4396	35
26	·18414	5·4307	34
27	·18444	5·4219	33
28	·18474	5·4130	32
29	·18504	5·4042	31
30	·18534	5·3955	30
31	·18564	5·3867	29
32	·18594	5·3780	28
33	·18624	5·3693	27
34	·18654	5·3696	26
35	·18684	5·3520	25
36	·18714	5·3434	24
37	·18744	5·3348	23
38	·18775	5·3263	22
39	·18805	5·3177	21
40	·18835	5·3092	20
41	·18865	5·3008	19
42	·18895	5·2923	18
43	·18925	5·2839	17
44	·18955	5·2755	16
45	·18986	5·2671	15
46	·19016	5·2588	14
47	·19046	5·2504	13
48	·19076	5·2421	12
49	·19106	5·2339	11
50	·19136	5·2256	10
51	·19166	5·2174	9
52	·19197	5·2092	8
53	·19227	5·2010	7
54	·19257	5·1929	6
55	·19287	5·1848	5
56	·19317	5·1767	4
57	·19347	5·1686	3
58	·19378	5·1605	2
59	·19408	5·1525	1
60	·19438	5·1445	79° 0
	Cotangent	Tangent	

79 DEGREES

TANGENTIAL ANGLES FOR CIRCULAR CURVES.

3000 feet 30 chains 300 mêtres	Radii.

BENDS.

In one	66 feet	chain	3¼ inches		
Rails	18 „	lengths	7/32	„	
In one	100 „	chain	5	„	
Rails	18 „	lengths	5/32	„	

SUPERELEVATION OF RAILS.

66 feet chain, 40 m. per hour 3″

100 feet chain, 45 m. per hour 2⅝″

Left-hand Reading		No. of Chains	Right-hand Reading	
359°	2·7′	1	0°	57·3′
358	5·4	2	1	54·6
357	8·1	3	2	51·9
356	10·8	4	3	49·2
355	13·5	5	4	46·5
354	16·2	6	5	43·8
353	18·9	7	6	41·1
352	21·6	8	7	38·4
351	24·3	9	8	35·7
350	27·0	10	9	33·0
349	29·7	11	10	30·2
348	32·4	12	11	27·5
347	35·1	13	12	24·8
346	37·9	14	13	22·1
345	40·6	15	14	19·4
344	43·3	16	15	16·7
343	46·0	17	16	14·0
342	48·7	18	17	11·3
341	51·4	19	18	8·6
340	54·1	20	19	5·9
339	56·8	21	20	3·2
338	59·5	22	21	0·5
338	2·2	23	21	57·8
337	4·9	24	22	55·1
336	7·6	25	23	52·4

11 Degrees

	Tangent	Cotangent	
11° 0′	·19438	5·1445	60′
1	·19468	5·1365	59
2	·19498	5·1286	58
3	·19529	5·1206	57
4	·19559	5·1127	56
5	·19589	5·1049	55
6	·19619	5·0970	54
7	·19649	5·0892	53
8	·19680	5·0813	52
9	·19710	5·0736	51
10	·19740	5·0658	50
11	·19770	5·0580	49
12	·19801	5·0503	48
13	·19832	5·0426	47
14	·19861	5·0349	46
15	·19891	5·0273	45
16	·19921	5·0197	44
17	·19952	5·0120	43
18	·19982	5·0045	42
19	·20012	4·9969	41
20	·20042	4·9894	40
21	·20073	4·9818	39
22	·20103	4·9743	38
23	·20133	4·9669	37
24	·20164	4·9594	36
25	·20194	4·9520	35
26	·20224	4·9445	34
27	·20254	4·9372	33
28	·20285	4·9298	32
29	·20315	4·9224	31
30	·20345	4·9151	30
31	·20376	4·9078	29
32	·20406	4·9005	28
33	·20436	4·8932	27
34	·20466	4·8860	26
35	·20497	4·8788	25
36	·20527	4·8716	24
37	·20557	4·8644	23
38	·20588	4·8572	22
39	·20618	4·8501	21
40	·20648	4·8430	20
41	·20679	4·8359	19
42	·20709	4·8288	18
43	·20739	4·8217	17
44	·20770	4·8147	16
45	·20800	4·8076	15
46	·20830	4·8006	14
47	·20861	4·7936	13
48	·20891	4·7867	12
49	·20921	4·7797	11
50	·20952	4·7728	10
51	·20982	4·7659	9
52	·21013	4·7590	8
53	·21043	4·7521	7
54	·21073	4·7453	6
55	·21104	4·7385	5
56	·21134	4·7316	4
57	·21164	4·7249	3
58	·21195	4·7181	2
59	·21225	4·7113	1
60	·21256	4·7046	78° 0
	Cotangent	Tangent	

78 Degrees

TANGENTIAL ANGLES FOR CIRCULAR CURVES.

3500 feet
35 chains } Radii.
350 mêtres

Bends.

In one 66 feet chain $2\frac{7}{8}$ inches
Rails 18 „ lengths $\frac{3}{16}$ „
In one 100 „ chain $4\frac{1}{4}$ „
Rails 18 „ lengths $\frac{1}{8}$ „

Superelevation of Rails.

66 feet chain, 40 m. per hour $2\frac{1}{2}$″
100 feet chain, 45 m. per hour $2\frac{1}{4}$″

Left-hand Reading	No. of Chains	Right-hand Reading
359° 10·9′	1	0° 49·1′
358 21·8	2	1 38·2
357 32·7	3	2 27·3
356 43·6	4	3 16·4
355 54·4	5	4 5·5
355 5·3	6	4 54·7
354 16·2	7	5 43·8
353 27·1	8	6 32·9
352 38·0	9	7 22·0
351 48·9	10	8 11·1
350 59·8	11	9 0·2
350 10·7	12	9 49·3
349 21·6	13	10 38·4
348 32·4	14	11 27·5
347 43·3	15	12 16·6
346 54·2	16	13 5·7
346 5·1	17	13 54·9
345 16·0	18	14 44·0
344 26·9	19	15 33·1
343 37·8	20	16 22·2
342 48·7	21	17 11·3
341 59·6	22	18 0·4
341 10·4	23	18 49·5
340 21·3	24	19 38 6
339 32·2	25	20 27·8

TABLE III.

12 Degrees

	Tangent	Cotangent	
12° 0′	·21256	4·7046	60′
1	·21286	4·6979	59
2	·21316	4·6912	58
3	·21347	4·6845	57
4	·21377	4·6778	56
5	·21408	4·6712	55
6	·21438	4·6645	54
7	·21469	4·6579	53
8	·21499	4·6513	52
9	·21529	4·6448	51
10	·21559	4·6382	50
11	·21590	4·6317	49
12	·21621	4·6251	48
13	·21651	4·6186	47
14	·21682	4·6121	46
15	·21712	4·6057	45
16	·21743	4·5992	44
17	·21773	4·5928	43
18	·21804	4·5864	42
19	·21834	4·5800	41
20	·21864	4·5736	40
21	·21895	4·5672	39
22	·21925	4·5609	38
23	·21956	4·5545	37
24	·21986	4·5482	36
25	·22017	4·5419	35
26	·22047	4·5356	34
27	·22078	4·5294	33
28	·22108	4·5231	32
29	·22139	4·5169	31
30	·22169	4·5107	30
31	·22200	4·5045	29
32	·22231	4·4983	28
33	·22261	4·4921	27
34	·22292	4·4860	26
35	·22322	4·4798	25
36	·22353	4·4737	24
37	·22383	4·4676	23
38	·22414	4·4615	22
39	·22444	4·4554	21
40	·22475	4·4494	20
41	·22505	4·4433	19
42	·22536	4·4373	18
43	·22567	4·4313	17
44	·22597	4·4253	16
45	·22628	4·4193	15
46	·22658	4·4133	14
47	·22689	4·4074	13
48	·22719	4·4015	12
49	·22750	4·3955	11
50	·22781	4·3896	10
51	·22811	4·3838	9
52	·22842	4·3779	8
53	·22872	4·3720	7
54	·22903	4·3662	6
55	·22934	4·3604	5
56	·22964	4·3545	4
57	·22995	4·3487	3
58	·23026	4·3430	2
59	·23056	4·3372	1
60	·23087	4·3314	77° 0
	Cotangent	Tangent	

77 Degrees

TANGENTIAL ANGLES FOR CIRCULAR CURVES.

4000 feet
40 chains } Radii.
400 mêtres

Bends.

In one 66 feet chain $2\frac{1}{2}$ inches
Rails 18 „ lengths $\frac{5}{32}$ „
In one 100 „ chain $3\frac{3}{4}$ „
Rails 18 „ lengths $\frac{3}{32}$ „

Superelevation of Rails.

66 feet chain, 45 m. per hour 3″
100 feet chain, 50 m. per hour $2\frac{1}{4}$″

Left-hand Reading	No. of Chains	Right-hand Reading
359° 17·0′	1	0° 43·0′
358 34·0	2	1 25·9
357 51·1	3	2 8·9
357 8·1	4	2 51·9
356 25·1	5	3 34·9
355 42·2	6	4 17·8
354 59·2	7	5 0·8
354 16·2	8	5 43·8
353 33·2	9	6 26·7
352 50·3	10	7 9·7
352 7·3	11	7 52·7
351 24·3	12	8 35·7
350 41·4	13	9 18·6
349 58·4	14	10 1·6
349 15·4	15	10 44·6
348 32·4	16	11 27·5
347 49·5	17	12 10·5
347 6·5	18	12 53·5
346 23·5	19	13 36·5
345 40·6	20	14 19·4
344 57·6	21	15 2·4
344 14·6	22	15 45·4
343 31·6	23	16 28·3
342 48·7	24	17 11·3
342 5·7	25	17 54·3

13 DEGREES

	Tangent	Cotangent	
13° 0′	·23087	4·3314	60′
1	·23117	4·3257	59
2	·23148	4·3200	58
3	·23179	4·3142	57
4	·23209	4·3085	56
5	·23240	4·3029	55
6	·23271	4·2972	54
7	·23314	4·2915	53
8	·23332	4·2859	52
9	·23363	4·2803	51
10	·23393	4·2747	50
11	·23424	4·2691	49
12	·23455	4·2635	48
13	·23485	4·2579	47
14	·23516	4·2523	46
15	·23547	4·2468	45
16	·23578	4·2413	44
17	·23608	4·2358	43
18	·23639	4·2302	42
19	·23670	4·2248	41
20	·23700	4·2193	40
21	·23731	4·2138	39
22	·23762	4·2084	38
23	·23793	4·2029	37
24	·23823	4·1975	36
25	·23854	4·1921	35
26	·23885	4·1867	34
27	·23916	4·1813	33
28	·23946	4·1760	32
29	·23977	4·1706	31
30	·24008	4·1652	30
31	·24039	4·1599	29
32	·24069	4·1546	28
33	·24100	4·1493	27
34	·24131	4·1440	26
35	·24162	4·1387	25
36	·24193	4·1335	24
37	·24223	4·1282	23
38	·24254	4·1230	22
39	·24285	4·1177	21
40	·24316	4·1125	20
41	·24347	4·1073	19
42	·24377	4·1021	18
43	·24408	4·0969	17
44	·24439	4·0918	16
45	·24470	4·0866	15
46	·24501	4·0815	14
47	·24532	4·0763	13
48	·24562	4·0712	12
49	·24593	4·0661	11
50	·24624	4·0610	10
51	·24655	4·0559	9
52	·24686	4·0509	8
53	·24717	4·0458	7
54	·24748	4·0408	6
55	·24778	4·0357	5
56	·24809	4·0307	4
57	·24840	4·0257	3
58	·24871	4·0207	2
59	·24902	4·0157	1
60	·24933	4·0107	76° 0
	Cotangent	Tangent	

76 DEGREES

TANGENTIAL ANGLES FOR CIRCULAR CURVES.

4500 feet
45 chains } Radii.
450 mêtres

BENDS.

In one 66 feet chain 2⅛ inches
Rails 18 „ lengths ⅛ „
In one 100 „ chain 3¼ „
Rails 18 „ lengths 1/16 „

SUPERELEVATION OF RAILS.

66 feet chain, 45 m. per hour 2⅝″
100 feet chain, 50 m. per hour 2⅛″

Left-hand Reading	No. of Chains	Right-hand Reading
359° 21·8′	1	0° 38·2′
358 43·6	2	1 16·4
358 5·4	3	1 54·6
357 27·2	4	2 32·8
356 49·0	5	3 11·0
356 10·1	6	3 49·2
355 32·6	7	4 27·4
354 54·4	8	5 5·6
354 16·2	9	5 43·8
353 38·0	10	6 22·0
352 59·8	11	7 0·2
352 21·6	12	7 38·4
351 43·4	13	8 16·6
351 5·2	14	8 54·7
350 27·0	15	9 32·9
349 48·8	16	10 11·1
349 10·6	17	10 49·3
348 32·4	18	11 27·5
347 54·2	19	12 5·7
347 16·0	20	12 43·9
346 37·9	21	13 22·1
345 59·7	22	14 0·3
345 21·5	24	14 38·5
344 43·3	25	15 16·7
344 5·1	26	15 54·9

14 Degrees

	Tangent	Cotangent	
14° 0′	·24933	4·0107	60′
1	·24964	4·0058	59
2	·24995	4·0008	58
3	·25026	3·9959	57
4	·25056	3·9909	56
5	·25087	3·9860	55
6	·25118	3·9811	54
7	·25149	3·9762	53
8	·25180	3·9713	52
9	·25211	3·9665	51
10	·25242	3·9616	50
11	·25273	3·9568	49
12	·25304	3·9519	48
13	·25335	3·9471	47
14	·25366	3·9423	46
15	·25397	3·9375	45
16	·25428	3·9327	44
17	·25459	3·9279	43
18	·25490	3·9231	42
19	·25521	3·9183	41
20	·25552	3·9136	40
21	·25583	3·9089	39
22	·25614	3·9041	38
23	·25645	3·8994	37
24	·25676	3·8947	36
25	·25707	3·8900	35
26	·25738	3·8853	34
27	·25769	3·8806	33
28	·25800	3·8760	32
29	·25831	3·8713	31
30	·25862	3·8667	30
31	·25893	3·8620	29
32	·25924	3·8574	28
33	·25955	3·8528	27
34	·25986	3·8482	26
35	·26017	3·8436	25
36	·26048	3·8390	24
37	·26079	3·8344	23
38	·26110	3·8299	22
39	·26141	3·8253	21
40	·26172	3·8208	20
41	·26203	3·8162	19
42	·26235	3·8117	18
43	·26266	3·8072	17
44	·26297	3·8027	16
45	·26328	3·7982	15
46	·26359	3·7937	14
47	·26390	3·7893	13
48	·26421	3·7848	12
49	·26452	3·7803	11
50	·26483	3·7759	10
51	·26515	3·7715	9
52	·26546	3·7670	8
53	·26577	3·7626	7
54	·26608	3·7582	6
55	·26639	3·7538	5
56	·26670	3·7494	4
57	·26701	3·7451	3
58	·26733	3·7407	2
59	·26764	3·7363	1
60	·26795	3·7320	75° 0
	Cotangent	Tangent	

75 Degrees

TANGENTIAL ANGLES FOR CIRCULAR CURVES.

5000 feet 50 chains 500 mêtres	Radii.

Bends.

In one 66 feet chain 2 inches
In one 100 „ chain 3 „

Superelevation of Rails.

66 feet chain, 50 m. per hour 2⅞″
100 feet chain, 50 m. per hour 2″

Left-hand Reading	No. of Chains	Right-hand Reading
359° 25·6′	1	0° 34·4′
358 51·2	2	1 8·7
358 16·9	3	1 43·1
357 42·5	4	2 17·5
357 8·1	5	2 51·9
356 33·7	6	3 26·3
355 59·3	7	4 0·6
355 25·0	8	4 35·0
354 50·6	9	5 9·4
354 16·2	10	5 43·8
353 41·8	11	6 18·1
353 7·5	12	6 52·5
352 33·1	13	7 26·9
351 58·7	14	8 1·3
351 24·3	15	8 35·7
350 50·0	16	9 10·0
350 15·6	17	9 44·4
349 41·2	18	10 18·8
349 6·8	19	10 53·1
348 32·4	20	11 27·5
347 58·1	21	12 1·9
347 23·7	22	12 36·3
346 49·3	23	13 10·7
346 14·9	24	13 45·0
345 40·6	25	14 19·4

15 DEGREES

	Tangent	Cotangent	
15° 0′	·26795	3·7320	60′
1	·26826	3·7277	59
2	·26857	3·7233	58
3	·26888	3·7190	57
4	·26920	3·7147	56
5	·26951	3·7104	55
6	·26982	3·7061	54
7	·27013	3·7018	53
8	·27044	3·6976	52
9	·27076	3·6933	51
10	·27107	3·6890	50
11	·27138	3·6848	49
12	·27169	3·6806	48
13	·27201	3·6763	47
14	·27232	3·6721	46
15	·27263	3·6679	45
16	·27294	3·6637	44
17	·27326	3·6595	43
18	·27357	3·6553	42
19	·27388	3·6512	41
20	·27419	3·6470	40
21	·27451	3·6428	39
22	·27482	3·6387	38
23	·27513	3·6346	37
24	·27544	3·6304	36
25	·27576	3·6263	35
26	·27607	3·6222	34
27	·27639	3·6181	33
28	·27670	3·6140	32
29	·27701	3·6099	31
30	·27732	3·6058	30
31	·27764	3·6018	29
32	·27795	3·5977	28
33	·27826	3·5937	27
34	·27858	3·5896	26
35	·27889	3·5856	25
36	·27921	3·5815	24
37	·27952	3·5775	23
38	·27983	3·5735	22
39	·28015	3·5695	21
40	·28046	3·5655	20
41	·28077	3·5615	19
42	·28109	3·5576	18
43	·28140	3·5536	17
44	·28172	3·5496	16
45	·28203	3·5457	15
46	·28234	3·5417	14
47	·28266	3·5378	13
48	·28297	3·5339	12
49	·28329	3·5300	11
50	·28360	3·5260	10
51	·28391	3·5221	9
52	·28423	3·5182	8
53	·28454	3·5144	7
54	·28486	3·5105	6
55	·28517	3·5066	5
56	·28549	3·5027	4
57	·28580	3·4989	3
58	·28612	3·4950	2
59	·28643	3·4912	1
60	·28675	3·4874	74° 0
	Cotangent	Tangent	

74 DEGREES

TANGENTIAL ANGLES FOR CIRCULAR CURVES.

5500 feet }
55 chains } Radii.
550 mêtres }

BENDS.

In one 66 feet chain 1⅞ inches
In one 100 „ chain 2⅝ „

SUPERELEVATION OF RAILS.

66 feet chain, 50 m. per hour 2½″
100 feet chain, 50 m. per hour 2″

Left-hand Reading	No. of Chains	Right-hand Reading
359° 28·7′	1	0° 31·2′
358 57·5	2	1 2·5
358 26·2	3	1 33·7
357 55 0	4	2 5·0
357 23·7	5	2 36·3
356 52·5	6	3 7·5
356 21·2	7	3 38·7
355 50·0	8	4 10·0
355 18·7	9	4 41·3
354 47·5	10	5 12·5
354 16·2	11	5 43·8
353 45·0	12	6 15·0
353 13·7	13	6 46·3
352 42·5	14	7 17·5
352 11·2	15	7 48·8
351 40·0	16	8 20·0
351 8·7	17	8 51·3
350 37·5	18	9 22·5
350 6·2	19	9 53·8
349 34·9	20	10 25·0
349 3·7	21	10 56·3
348 32·4	22	11 27·5
348 1·2	23	11 58·8
347 29·9	24	12 30·0
346 58·7	25	13 1·3

TABLE III.

16 Degrees

	Tangent	Cotangent	
16° 0′	·28675	3·4874	60′
1	·28706	3·4835	59
2	·28738	3·4797	58
3	·28769	3·4759	57
4	·28801	3·4721	56
5	·28832	3·4683	55
6	·28864	3·4645	54
7	·28895	3·4608	53
8	·28927	3·4570	52
9	·28958	3·4532	51
10	·28990	3·4495	50
11	·29021	3·4457	49
12	·29053	3·4420	48
13	·29084	3·4382	47
14	·29116	3·4345	46
15	·29147	3·4308	45
16	·29179	3·4271	44
17	·29210	3·4234	43
18	·29242	3·4197	42
19	·29274	3·4160	41
20	·29305	3·4123	40
21	·29337	3·4086	39
22	·29368	3·4050	38
23	·29400	3·4013	37
24	·29432	3·3977	36
25	·29463	3·3940	35
26	·29495	3·3904	34
27	·29526	3·3867	33
28	·29558	3·3831	32
29	·29590	3·3795	31
30	·29621	3·3759	30
31	·29653	3·3723	29
32	·29685	3·3687	28
33	·29716	3·3651	27
34	·29748	3·3615	26
35	·29780	3·3580	25
36	·29811	3·3544	24
37	·29843	3·3508	23
38	·29875	3·3473	22
39	·29906	3·3437	21
40	·29938	3·3402	20
41	·29970	3·3366	19
42	·30001	3·3331	18
43	·30033	3·3296	17
44	·30065	3·3261	16
45	·30097	3·3226	15
46	·30128	3·3191	14
47	·30160	3·3156	13
48	·30192	3·3121	12
49	·30224	3·3086	11
50	·30255	3·3052	10
51	·30287	3·3017	9
52	·30319	3·2982	8
53	·30351	3·2948	7
54	·30382	3·2913	6
55	·30414	3·2879	5
56	·30446	3·2845	4
57	·30478	3·2810	3
58	·30509	3·2776	2
59	·30541	3·2742	1
60	·30573	3·2708	73° 0
	Cotangent	Tangent	

73 Degrees

TANGENTIAL ANGLES FOR CIRCULAR CURVES.

6000 feet }
60 chains } Radii.
600 mêtres }

Bends.

In one 66 feet chain 1⅝ inches
In one 100 „ chain 2¼ „

Superelevation of Rails.

66 feet chain, 50 m. per hour 2¼″
100 feet chain, 50 m. per hour 2″

Left-hand Reading	No. of Chains	Right-hand Reading
359° 31·3′	1	0° 28·6′
359 2·7	2	0 57·3
358 34·1	3	1 25·9
358 5·4	4	1 54·6
357 36·7	5	2 23·2
357 8·1	6	2 51·9
356 39·5	7	3 20·5
356 10·8	8	3 49·2
355 42·2	9	4 17·8
355 13·5	10	4 46·5
354 44·9	11	5 15·1
354 16·2	12	5 43·8
353 47·6	13	6 12·4
353 18·9	14	6 41·1
352 50·3	15	7 9·7
352 21·6	16	7 38·4
351 53·0	17	8 7·0
351 24·3	18	8 35·6
350 55·7	19	9 4·3
350 27·0	20	9 33·0
349 58·4	21	10 1·6
349 29·7	22	10 30·2
349 1·1	23	10 58·9
348 32·4	24	11 27·5
348 3·8	25	11 56·2

17 Degrees

	Tangent	Cotangent	
17° 0′	·30573	3·2708	60′
1	·30605	3·2674	59
2	·30637	3·2640	58
3	·30669	3·2606	57
4	·30700	3·2572	56
5	·30732	3·2539	55
6	·30764	3·2505	54
7	·30796	3·2471	53
8	·30828	3·2438	52
9	·30860	3·2404	51
10	·30891	3·2371	50
11	·30923	3·2338	49
12	·30955	3·2304	48
13	·30987	3·2271	47
14	·31019	3·2238	46
15	·31051	3·2205	45
16	·31083	3·2172	44
17	·31114	3·2139	43
18	·31146	3·2106	42
19	·31178	3·2073	41
20	·31210	3·2040	40
21	·31242	3·2007	39
22	·31274	3·1975	38
23	·31306	3·1942	37
24	·31338	3·1910	36
25	·31370	3·1877	35
26	·31402	3·1845	34
27	·31434	3·1812	33
28	·31466	3·1780	32
29	·31498	3·1748	31
30	·31530	3·1715	30
31	·31562	3·1683	29
32	·31594	3·1651	28
33	·31626	3·1619	27
34	·3165	3·1587	26
35	·31690	3·1555	25
36	·31722	3·1523	24
37	·31754	3·1492	23
38	·31786	3·1460	22
39	·31818	3·1428	21
40	·31850	3·1397	20
41	·31882	3·1365	19
42	·31914	3·1334	18
43	·31946	3·1302	17
44	·31978	3·1271	16
45	·32010	3·1239	15
46	·32042	3·1208	14
47	·32074	3·1177	13
48	·32106	3·1146	12
49	·32139	3·1115	11
50	·32171	3·1084	10
51	·32203	3·1053	9
52	·32235	3·1022	8
53	·32267	3·0991	7
54	·32299	3·0960	6
55	·32331	3·0929	5
56	·32363	3·0899	4
57	·32396	3·0868	3
58	·32428	3·0837	2
59	·32460	3·0807	1
60	·32492	3·0776	72° 0
	Cotangent	Tangent	

72 Degrees

TANGENTIAL ANGLES FOR CIRCULAR CURVES.

6500 feet }
65 chains } Radii.
650 mêtres }

Bends.

In one 66 feet chain 1½ inches
In one 100 „ chain 2¼ „

Superelevation of Rails.

66 feet chain, 50 m. per hour 2″
100 feet chain, 50 m. per hour 1¾″

Left-hand Reading	No. of Chains	Right-hand Reading
359° 33·5′	1	0° 26·4′
359 7·1	2	0 52·9
358 40·7	3	1 19·3
358 14·2	4	1 45·8
357 47·8	5	2 12·2
357 21·3	6	2 38·7
356 54·9	7	3 5·1
356 28·4	8	3 31·5
356 2·0	9	3 58·0
355 35·5	10	4 24·4
355 9·1	11	4 50·9
354 42·7	12	5 17·3
354 16·2	13	5 43·8
353 49·8	14	6 10·2
353 23·3	15	6 36·7
352 56·9	16	7 3·1
352 30·4	17	7 29·5
352 4·0	18	7 56·0
351 37·6	19	8 22·4
351 11·1	20	8 48·9
350 44·7	21	9 15·3
350 18·2	22	9 41·8
349 51·8	23	10 8·2
349 25·3	24	10 34·6
348 58·9	25	11 1·1

18 DEGREES

	Tangent	Cotangent	
18° 0	·32492	3·0776	60′
1	·32524	3·0746	59
2	·32556	3·0716	58
3	·32588	3·0685	57
4	·32620	3·0655	56
5	·32653	3·0625	55
6	·32685	3·0595	54
7	·32717	3·0564	53
8	·32749	3·0534	52
9	·32782	3·0504	51
10	·32814	3·0474	50
11	·32846	3·0445	49
12	·32878	3·0415	48
13	·32911	3·0385	47
14	·32943	3·0355	46
15	·32975	3·0325	45
16	·33007	3·0296	44
17	·33040	3·0266	43
18	·33072	3·0237	42
19	·33104	3·0207	41
20	·33136	3·0178	40
21	·33168	3·0148	39
22	·33201	3·0119	38
23	·33233	3·0090	37
24	·33266	3·0061	36
25	·33298	3·0031	35
26	·33330	3·0002	34
27	·33363	2·9973	33
28	·33395	2·9944	32
29	·33427	2·9915	31
30	·33460	2·9886	30
31	·33492	2·9857	29
32	·33524	2·9829	28
33	·33557	2·9800	27
34	·33589	2·9771	26
35	·33621	2·9743	25
36	·33654	2·9714	24
37	·33686	2·9685	23
38	·33719	2·9657	22
39	·33751	2·9628	21
40	·33783	2·9600	20
41	·33816	2·9572	19
42	·33848	2·9543	18
43	·33881	2·9515	17
44	·33913	2·9487	16
45	·33945	2·9459	15
46	·33978	2·9430	14
47	·34010	2·9402	13
48	·34043	2·9374	12
49	·34075	2·9346	11
50	·34108	2·9318	10
51	·34140	2·9290	9
52	·34173	2·9263	8
53	·34205	2·9235	7
54	·34238	2·9207	6
55	·34270	2·9179	5
56	·34303	2·9152	4
57	·34335	2·9124	3
58	·34367	2·9097	2
59	·34400	2·9069	1
60	·34433	2·9042	71° 0
	Cotangent	Tangent	

71 DEGREES

TANGENTIAL ANGLES FOR CIRCULAR CURVES.

7000 feet }
70 chains } Radii.
700 mêtres }

BENDS.

In one 66 feet chain $1\frac{3}{8}$ inches
In one 100 „ chain $2\frac{1}{8}$ „

SUPERELEVATION OF RAILS.

66 feet chain, 45 m. per hour $1\frac{1}{2}''$
100 feet chain, 50 m. per hour 1″

Left-hand Reading	No. of Chains	Right-hand Reading
359° 35·4′	1	0° 24·5′
359 11·0	2	0 49·1
358 46·3	3	1 13·6
358 21·8	4	1 38·2
357 57·2	5	2 2·8
357 32·7	6	2 27·3
357 8·1	7	2 51·9
356 43·5	8	3 16·4
356 19·0	9	3 41·0
355 54·4	10	4 5·5
355 29·9	11	4 30·1
355 5·3	12	4 54·6
354 40·8	13	5 19·2
354 16·2	14	5 43·8
353 51·7	15	6 8·3
353 27·1	16	6 32·9
353 2·5	17	6 57·4
352 38·0	18	7 22·0
352 13·4	19	7 46·5
351 48·9	20	8 11·1
351 24·3	21	8 35·6
350 59·8	22	9 0·2
350 35·2	23	9 24·8
350 10·7	24	9 49·3
349 46·1	25	10 13·9

19 Degrees

	Tangent	Cotangent	
19° 0′	·34433	2·9042	60′
1	·34465	2·9014	59
2	·34498	2·8987	58
3	·34530	2·8959	57
4	·34563	2·8932	56
5	·34596	2·8905	55
6	·34628	2·8878	54
7	·34661	2·8851	53
8	·34693	2·8824	52
9	·34726	2·8796	51
10	·34758	2·8769	50
11	·34791	2·8743	49
12	·34823	2·8716	48
13	·34856	2·8689	47
14	·34889	2·8662	46
15	·34922	2·8635	45
16	·34954	2·8608	44
17	·34987	2·8582	43
18	·35020	2·8555	42
19	·35052	2·8528	41
20	·35085	2·8502	40
21	·35118	2·8475	39
22	·35150	2·8449	38
23	·35183	2·8422	37
24	·35216	2·8396	36
25	·35248	2·8370	35
26	·35281	2·8343	34
27	·35314	2·8317	33
28	·35346	2·8291	32
29	·35379	2·8265	31
30	·35412	2·8239	30
31	·35444	2·8213	29
32	·35477	2·8187	28
33	·35510	2·8161	27
34	·35543	2·8135	26
35	·35576	2·8109	25
36	·35608	2·8083	24
37	·35641	2·8057	23
38	·35674	2·8031	22
39	·35707	2·8005	21
40	·35740	2·7980	20
41	·35772	2·7954	19
42	·35805	2·7928	18
43	·35838	2·7903	17
44	·35871	2·7877	16
45	·35904	2·7852	15
46	·35937	2·7826	14
47	·35969	2·7801	13
48	·36002	2·7776	12
49	·36035	2·7750	11
50	·36068	2·7725	10
51	·36101	2·7700	9
52	·36134	2·7674	8
53	·36167	2·7649	7
54	·36199	2·7624	6
55	·36232	2·7599	5
56	·36265	2·7574	4
57	·36298	2·7549	3
58	·36331	2·7524	2
59	·36364	2·7499	1
60	·36397	2·7474	70° 0
	Cotangent	Tangent	

70 Degrees

TANGENTIAL ANGLES FOR CIRCULAR CURVES.

7500 feet }
75 chains } Radii.
750 mêtres }

Bends.

In one 66 feet chain 1¼ inches
In one 100 „ chain 2 „

Superelevation of Rails.

66 feet chain, 45 m. per hour 1½″
100 feet chain, 50 m. per hour 1″

Left-hand Reading	No. of Chains	Right-hand Reading
359° 37·1′	1	0° 22·9′
359 14·2	2	0 45·8
358 51·2	3	1 8·7
358 28·3	4	1 31·7
358 5·4	5	1 54·6
357 42·5	6	2 17·5
357 19·6	7	2 40·4
356 56·6	8	3 3·3
356 33·7	9	3 26·3
356 10·8	10	3 49·2
355 47·9	11	4 12·1
355 25·0	12	4 35·0
355 2·1	13	4 57·9
354 39·1	14	5 20·8
354 16·2	15	5 43·8
353 53·3	16	6 6·7
353 30·4	17	6 29·6
353 7·5	18	6 52·5
352 44·5	19	7 15·4
352 21·6	20	7 38·4
351 58·7	21	8 1·3
351 35·8	22	8 24·2
351 12·9	23	8 47·1
350 50·0	24	9 10·0
350 27·0	25	9 32·9

TABLE III.

20 Degrees

	Tangent	Cotangent	
20° 0′	·36397	2·7474	60′
1	·36430	2·7449	59
2	·36463	2·7425	58
3	·36496	2·7400	57
4	·36529	2·7375	56
5	·36562	2·7350	55
6	·36595	2·7326	54
7	·36628	2·7301	53
8	·36661	2·7277	52
9	·36694	2·7252	51
10	·36727	2·7228	50
11	·36760	2·7203	49
12	·36793	2·7179	48
13	·36826	2·7154	47
14	·36859	2·7130	46
15	·36892	2·7106	45
16	·36925	2·7081	44
17	·36958	2·7057	43
18	·36991	2·7033	42
19	·37024	2·7009	41
20	·37057	2·6985	40
21	·37090	2·6961	39
22	·37123	2·6937	38
23	·37157	2·6913	37
24	·37190	2·6889	36
25	·37223	2·6865	35
26	·37256	2·6841	34
27	·37289	2·6817	33
28	·37322	2·6793	32
29	·37355	2·6769	31
30	·37388	2·6746	30
31	·37422	2·6722	29
32	·37455	2·6698	28
33	·37488	2·6675	27
34	·37521	2·6651	26
35	·37554	2·6628	25
36	·37687	2·6604	24
37	·37620	2·6581	23
38	·37654	2·6557	22
39	·37687	2·6534	21
40	·37720	2·6510	20
41	·37754	2·6487	19
42	·37787	2·6464	18
43	·37820	2·6440	17
44	·37853	2·6417	16
45	·37887	2·6394	15
46	·37920	2·6371	14
47	·37953	2·6348	13
48	·37986	2·6325	12
49	·38020	2·6302	11
50	·38053	2·6279	10
51	·38086	2·6256	9
52	·38120	2·6233	8
53	·38153	2·6210	7
54	·38186	2·6187	6
55	·38220	2·6164	5
56	·38253	2·6141	4
57	·38286	2·6118	3
58	·38320	2·6096	2
59	·38353	2·6073	1
60	·38386	2·6050	69° 0
	Cotangent	Tangent	

69 Degrees

TANGENTIAL ANGLES FOR CIRCULAR CURVES.

Radius 80 chains.

Bends.

In one 66 feet chain 1¼ inch
In one 100 „ chain 1¾ „

Superelevation of Rails.

66 feet chain, 50 m. per hour 1½″
100 feet chain, 50 m. per hour 1″

Left-hand Reading		No. of Chains	Right-hand Reading	
359°	38·5′	1	0°	21·5′
359	17·0	2	0	43·0
358	55·5	3	1	4·4
358	34·1	4	1	25·9
358	12·6	5	1	47·4
357	51·1	6	2	8·9
357	29·6	7	2	30·4
357	8·1	8	2	51·9
356	46·6	9	3	13·4
356	25·1	10	3	34·9
356	3·6	11	3	56·3
355	42·2	12	4	17·8
355	20·1	13	4	39·3
354	59·2	14	5	0·8
354	37·7	15	5	22·3
354	16·2	16	5	43·8
353	54·7	17	6	5·3
353	33·2	18	6	26·7
353	11·8	19	6	48·2
352	50·3	20	7	9·7
352	28·8	21	7	31·2
352	7·3	22	7	52·7
351	45·8	23	8	14·2
351	24·3	24	8	35·7
351	2·8	25	8	57·1

21 DEGREES

	Tangent	Cotangent	
21° 0′	·38386	2·6050	60′
1	·38420	2·6028	59
2	·38453	2·6005	58
3	·38487	2·5983	57
4	·38520	2·5960	56
5	·38553	2·5938	55
6	·38587	2·5915	54
7	·38620	2·5893	53
8	·38654	2·5870	52
9	·38687	2·5848	51
10	·38721	2·5826	50
11	·38754	2·5803	49
12	·38787	2·5781	48
13	·38821	2·5759	47
14	·38854	2·5737	46
15	·38888	2·5714	45
16	·38921	2·5692	44
17	·38955	2·5670	43
18	·38988	2·5648	42
19	·39022	2·5626	41
20	·39055	2·5604	40
21	·39088	2·5582	39
22	·39122	2·5560	38
23	·39156	2·5538	37
24	·39186	2·5516	36
25	·39223	2·5495	35
26	·39256	2·5473	34
27	·39290	2·5451	33
28	·39324	2·5429	32
29	·39357	2·5408	31
30	·39391	2·5386	30
31	·39425	2·5364	29
32	·39458	2·5343	28
33	·39492	2·5321	27
34	·39526	2·5300	26
35	·39559	2·5278	25
36	·39593	2·5257	24
37	·39626	2·5235	23
38	·39660	2·5214	22
39	·39694	2·5192	21
40	·39727	2·5171	20
41	·39761	2·5150	19
42	·39795	2·5128	18
43	·39829	2·5107	17
44	·39862	2·5086	16
45	·39896	2·5065	15
46	·39930	2·5044	14
47	·39963	2·5022	13
48	·39997	2·5001	12
49	·40031	2·4980	11
50	·40065	2·4959	10
51	·40098	2·4938	9
52	·40132	2·4917	8
53	·40166	2·4896	7
54	·40200	2·4875	6
55	·40234	2·4854	5
56	·40267	2·4834	4
57	·40301	2·4813	3
58	·40335	2·4792	2
59	·40369	2·4771	1
60	·40403	2·4750	68° 0
	Cotangent	Tangent	

68 DEGREES

TANGENTIAL ANGLES FOR CIRCULAR CURVES.

Radius 85 chains.

BENDS.

In one 66 feet chain 1⅛ inch

In one 100 „ chain 1¾ „

SUPERELEVATION OF RAILS.

66 feet chain, 50 m. per hour 1½″

100 feet chain, 50 m. per hour 1″

Left-hand Reading		No. of Chains	Right-hand Reading	
359°	39·8′	1	0°	20·2′
359	19·5	2	0	40·4
358	59·3	3	1	0·6
358	39·1	4	1	20·8
358	18·9	5	1	41·1
357	58·7	6	2	1·3
357	38·4	7	2	21·5
357	18·2	8	2	41·8
356	58·0	9	3	2·0
356	37·8	10	3	22·2
356	17·5	11	3	42·4
355	57·3	12	4	2·6
355	37·1	13	4	22·9
355	16·9	14	4	43·1
354	56·7	15	5	3·3
354	36·4	16	5	23·5
354	16·2	17	5	43·8
353	56·0	18	6	4·0
353	35·8	19	6	24·2
353	15·6	20	6	44·4
352	55·3	21	7	4·7
352	35·1	22	7	24·9
352	14·9	23	7	45·1
351	54·7	24	8	5·3
351	34·3	25	8	25·5

TABLE III.

	22 DEGREES		23 DEGREES		24 DEGREES		
	Tangent	Cotangent	Tangent	Cotangent	Tangent	Cotangent	
0′	·40403	2·4750	·42447	2·3558	·44522	2·2460	60
1	·40436	2·4730	·42481	2·3539	·44557	2·2442	59
2	·40470	2·4709	·42516	2·3520	·44592	2·2425	58
3	·40504	2·4688	·42550	2·3501	·44627	2·2407	57
4	·40538	2·4668	·42584	2·3482	·44662	2·2390	56
5	·40572	2·4647	·42619	2·3463	·44697	2·2372	55
6	·40606	2·4627	·42653	2·3444	·44732	2·2355	54
7	·40640	2·4606	·42688	2·3425	·44767	2·2337	53
8	·40673	2·4585	·42722	2·3406	·44802	2·2320	52
9	·40707	2·4565	·42756	2·3388	·44836	2·2303	51
10	·40741	2·4545	·42791	2·3369	·44871	2·2285	50
11	·40775	2·4524	·42825	2·3350	·44906	2·2268	49
12	·40809	2.4504	·42860	2·3331	·44941	2·2251	48
13	·40843	2·4483	·42894	2·3313	·44976	2·2233	47
14	·40877	2·4463	·42928	2·3294	·45011	2·2216	46
15	·40911	2·4443	·42963	2·3275	·45046	2·2199	45
16	·40945	2·4422	·42997	2·3256	·45081	2·2181	44
17	·40979	2·4402	·43032	2·3238	·45116	2·2164	43
18	·41013	2·4382	·43066	2·3219	·45151	2·2147	42
19	·41047	2·4362	·43101	2·3201	·45186	2·2130	41
20	·41081	2·4342	·43135	2·3182	·45221	2·2113	40
21	·41115	2·4322	·43170	2·3164	·45256	2·2096	39
22	·41149	2·4301	·43204	2·3145	·45291	2·2079	38
23	·41183	2·4281	·43239	2·3127	·45326	2·2061	37
24	·41217	2·4261	·43273	2·3108	·45362	2·2044	36
25	·41251	2·4241	·43308	2·3090	·45397	2·2027	35
26	·41285	2·4221	·43342	2·3071	·45432	2·2010	34
27	·41319	2·4201	·43377	2·3053	·45467	2·1993	33
28	·41353	2·4181	·43412	2·3035	·45502	2·1976	32
29	·41387	2·4162	·43446	2·3016	·45537	2·1959	31
30	·41421	2·4142	·43481	2·2998	·45572	2·1942	30
31	·41455	2·4122	·43515	2·2980	·45607	2·1926	29
32	·41489	2·4102	·43550	2·2961	·45642	2·1909	28
33	·41524	2·4082	·43585	2·2943	·45678	2·1892	27
34	·41558	2·4062	·43619	2·2925	·45713	2·1875	26
35	·41592	2·4043	·43654	2·2907	·45748	2·1858	25
36	·41626	2·4023	·43688	2·2889	·45783	2·1841	24
37	·41660	2·4003	·43723	2·2870	·45818	2·1825	23
38	·41694	2·3984	·43758	2·2852	·45853	2·1808	22
39	·41728	2·3964	·43792	2·2834	·45889	2·1791	21
40	·41762	2·3944	·43827	2·2816	·45924	2·1774	20
41	·41797	2·3925	·43862	2·2798	·45959	2·1758	19
42	·41831	2·3905	·43896	2·2780	·45994	2·1741	18
43	·41865	2·3886	·43931	2·2762	·46030	2·1724	17
44	·41899	2·3866	·43966	2·2744	·46065	2·1708	16
45	·41933	2·3847	·44001	2·2726	·46100	2·1691	15
46	·41968	2·3827	·44035	2·2708	·46135	2·1675	14
47	·42001	2·3808	·44070	2·2690	·46171	2·1658	13
48	·42036	2·3789	·44105	2·2673	·46206	2·1641	12
49	·42070	2·3769	·44140	2·2655	·46241	2·1625	11
50	·42115	2·3750	·44174	2·2637	·46277	2·1608	10
51	·42139	2·3731	·44209	2·2619	·46312	2·1592	9
52	·42173	2·3711	·44244	2·2601	·46347	2·1576	8
53	·42207	2·3692	·44279	2·2584	·46383	2·1559	7
54	·42242	2·3673	·44313	2·2566	·46418	2·1543	6
55	·42276	2·3654	·44348	2·2548	·46453	2·1526	5
56	·42310	2·3634	·44383	2·2530	·46489	2·1510	4
57	·42344	2·3615	·44418	2·2513	·46524	2·1494	3
58	·42379	2·3596	·44453	2·2495	·46559	2·1477	2
59	·42413	2·3577	·44488	2·2477	·46595	2·1461	1
60	·42447	2·3558	·44522	2·2460	·46630	2·1445	0
	Cotangent	Tangent	Cotangent	Tangent	Cotangent	Tangent	
	67 DEGREES		66 DEGREES		65 DEGREES		

TABLE III.

	25 Degrees		26 Degrees		27 Degrees		
	Tangent	Cotangent	Tangent	Cotangent	Tangent	Cotangent	
0′	·46630	2·1445	·48773	2·0503	·50952	1·9626	60′
1	·46666	2·1428	·48809	2·0487	·50989	1·9612	59
2	·46701	2·1412	·48845	2·0472	·51025	1·9597	58
3	·46737	2·1396	·48881	2·0457	·51062	1·9583	57
4	·46772	2·1380	·48917	2·0442	·51099	1·9569	56
5	·46807	2·1363	·48953	2·0427	·51135	1·9555	55
6	·46843	2·1347	·48989	2·0412	·51172	1·9541	54
7	·46878	2·1331	·49025	2·0397	·51209	1·9527	53
8	·46914	2·1315	·49061	2·0382	·51246	1·9513	52
9	·46949	2·1299	·49097	2·0367	·51282	1·9499	51
10	·46985	2·1283	·49133	2·0352	·51319	1·9485	50
11	·47020	2·1267	·49169	2·0337	·51356	1·9471	49
12	·47056	2·1251	·49206	2·0322	·51393	1·9457	48
13	·47091	2·1235	·49242	2·0307	·51429	1·9443	47
14	·47127	2·1219	·49278	2·0292	·51466	1·9430	46
15	·47163	2·1203	·49314	2·0277	·51503	1·9416	45
16	·47198	2·1187	·49350	2·0263	·51540	1·9402	44
17	·47234	2·1171	·49386	2·0248	·51577	1·9388	43
18	·47269	2·1155	·49423	2·0233	·51613	1·9374	42
19	·47305	2·1139	·49459	2·0218	·51650	1·9360	41
20	·47340	2·1123	·49495	2·0203	·51687	1·9347	40
21	·47376	2·1107	·49531	2·0189	·51724	1·9333	39
22	·47412	2·1091	·49567	2·0174	·51761	1·9319	38
23	·47447	2·1075	·49604	2·0159	·51798	1·9305	37
24	·47483	2·1059	·49640	2·0144	·51835	1·9291	36
25	·47519	2·1044	·49676	2·0130	·51871	1·9278	35
26	·47554	2·1028	·49712	2·0115	·51908	1·9264	34
27	·47590	2·1012	·49749	2·0100	·51945	1·9250	33
28	·47626	2·0996	·49785	2·0086	·51982	1·9237	32
29	·47661	2·0981	·49821	2·0071	·52019	1·9223	31
30	·47697	2·0965	·49858	2·0056	·52056	1·9209	30
31	·47733	2·0949	·49894	2·0042	·52093	1·9196	29
32	·47768	2·0934	·49930	2·0027	·52130	1·9182	28
33	·47804	2·0918	·49967	2·0013	·52167	1·9168	27
34	·47840	2·0902	·50003	1·9998	·52204	1·9155	26
35	·47876	2·0887	·50039	1·9984	·52241	1·9141	25
36	·47911	2·0871	·50076	1·9969	·52278	1·9128	24
37	·47947	2·0856	·50112	1·9955	·52315	1·9114	23
38	·47983	2·0840	·50149	1·9940	·52352	1·9101	22
39	·48019	2·0824	·50185	1·9926	·52389	1·9087	21
40	·48055	2·0809	·50221	1·9911	·52426	1·9074	20
41	·48090	2·0793	·50258	1·9897	·52464	1·9060	19
42	·48126	2·0778	·50294	1·9882	·52501	1·9047	18
43	·48162	2·0763	·50331	1·9868	·52538	1·9033	17
44	·48198	2·0747	·50367	1·9854	·52575	1·9020	16
45	·48234	2·0732	·50404	1·9839	·52612	1·9006	15
46	·48270	2·0716	·50440	1·9825	·52649	1·8993	14
47	·48306	2·0701	·50477	1·9810	·52686	1·8980	13
48	·48341	2·0685	·50513	1·9796	·52724	1·8966	12
49	·48377	2·0670	·50550	1·9782	·52761	1·8953	11
50	·48413	2·0655	·50586	1·9768	·52798	1·8939	10
51	·48449	2·0640	·50623	1·9753	·52835	1·8926	9
52	·48485	2·0624	·50659	1·9739	·52872	1·8913	8
53	·48521	2·0609	·50696	1·9725	·52910	1·8900	7
54	·48557	2·0594	·50732	1·9711	·52947	1·8886	6
55	·48593	2·0578	·50769	1·9696	·52984	1·8873	5
56	·48629	2·0563	·50806	1·9682	·53021	1·8860	4
57	·48665	2·0548	·50842	1·9668	·53059	1·8846	3
58	·48701	2·0533	·50879	1·9654	·53096	1·8833	2
59	·48737	2·0518	·50915	1·9640	·53133	1·8820	1
60	·48773	2·0503	·50952	1·9626	·53170	1·8807	0
	Cotangent	Tangent	Cotangent	Tangent	Cotangent	Tangent	
	64 Degrees		63 Degrees		62 Degrees		

TABLE III.

	28 Degrees		29 Degrees		30 Degrees		
	Tangent	Cotangent	Tangent	Cotangent	Tangent	Cotangent	
0′	·53170	1·8807	·55430	1·8048	·57735	1·7320	60′
1	·53208	1·8794	·55468	1·8025	·57773	1·7308	59
2	·53245	1·8780	·55506	1·8013	·57812	1·7297	58
3	·53282	1·8767	·55545	1·8001	·57851	1·7285	57
4	·53320	1·8754	·55583	1·7998	·57890	1·7274	56
5	·53357	1·8741	·55621	1·797	·57929	1·7262	55
6	·53395	1·8728	·55659	1·7966	·57967	1·7250	54
7	·53432	1·8715	·55697	1·7954	·58006	1·7239	53
8	·53469	1·8702	·55735	1·7941	·58045	1·7227	52
9	·53507	1·8689	·55773	1·7929	·58084	1·7216	51
10	·53544	1·8676	·55811	1·7917	·58123	1·7204	50
11	·53582	1·8662	·55849	1·7905	·58162	1·7193	49
12	·53619	1·8649	·55888	1·7892	·58201	1·7181	48
13	·53656	1·8636	·55926	1·7880	·58240	1·7170	47
14	·53694	1·8623	·55964	1·7868	·58279	1·7158	46
15	·53731	1·8610	·56002	1·7856	·58318	1·7147	45
16	·53769	1·8597	·56040	1·7844	·58357	1·7135	44
17	·53806	1·8584	·56079	1·7831	·58396	1·7124	43
18	·53844	1·8572	·56117	1·7819	·58435	1·7112	42
19	·53881	1·8559	·56155	1·7807	·58474	1·7101	41
20	·53919	1·8546	·56193	1·7795	·58513	1·7090	40
21	·53957	1·8533	·56232	1·7783	·58552	1·7078	39
22	·53994	1·8520	·56270	1·7771	·58591	1·7067	38
23	·54032	1·8507	·56308	1·7759	·58630	1·7055	37
24	·54069	1·8494	·56347	1·7747	·58669	1·7044	36
25	·54107	1·8481	·56385	1·7735	·58708	1·7033	35
26	·54145	1·8468	·56423	1·7723	·58747	1·7021	34
27	·54182	1·8456	·56462	1·7710	·58787	1·7010	33
28	·54220	1·8443	·56500	1·7698	·58826	1·6999	32
29	·54257	1·8430	·56538	1·7686	·58865	1·6987	31
30	·54295	1·8417	·56577	1·7674	·58904	1·6976	30
31	·54333	1·8404	·56615	1·7662	·58943	1·6965	29
32	·54370	1·8392	·56654	1·7650	·58982	1·6954	28
33	·54408	1·8379	·56692	1·7639	·59022	1·6942	27
34	·54446	1·8366	·56730	1·7627	·59061	1·6931	26
35	·54484	1·8353	·56769	1·7615	·59100	1·6920	25
36	·54521	1·8341	·56807	1·7603	·59139	1·6909	24
37	·54559	1·8328	·56846	1·7591	·59179	1·6897	23
38	·54597	1·8315	·56884	1·7579	·59218	1·6886	22
39	·54635	1·8303	·56923	1·7567	·59257	1·6875	21
40	·54672	1·8290	·56961	1·7555	·59296	1·6864	20
41	·54710	1·8277	·57000	1·7543	·59336	1·6853	19
42	·54748	1·8265	·57038	1·7531	·59375	1·6841	18
43	·54786	1·8252	·57077	1·7520	·59415	1·6830	17
44	·54824	1·8240	·57116	1·7508	·59454	1·6819	16
45	·54861	1·8227	·57154	1·7496	·59493	1·6808	15
46	·54899	1·8215	·57193	1·7484	·59533	1·6797	14
47	·54937	1·8202	·57231	1·7472	·59572	1·6786	13
48	·54975	1·8189	·57270	1·7460	·59611	1·6775	12
49	·55013	1·8177	·57309	1·7449	·59651	1·6764	11
50	·55051	1·8164	·57347	1·7437	·59690	1·6752	10
51	·55089	1·8152	·57386	1·7425	·59730	1·6741	9
52	·55127	1·8139	·57425	1·7413	·59769	1·6730	8
53	·55165	1·8127	·57463	1·7402	·59809	1·6719	7
54	·55202	1·8114	·57502	1·7390	·59848	1·6708	6
55	·55240	1·8102	·57541	1·7378	·59888	1·6697	5
56	·55278	1·8090	·57579	1·7367	·59927	1·6686	4
57	·55316	1·8077	·57618	1·7355	·59967	1·6675	3
58	·55354	1·8065	·57657	1·7343	·60006	1·6664	2
59	·55392	1·8052	·57696	1·7332	·60046	1·6653	1
60	·55430	1·8040	·57735	1·7320	·60086	1·6642	0
	Cotangent	Tangent	Cotangent	Tangent	Cotangent	Tangent	
	61 Degrees		60 Degrees		59 Degrees		

TABLE III.

	31 Degrees		32 Degrees		33 Degrees		
	Tangent	Cotangent	Tangent	Cotangent	Tangent	Cotangent	
0′	·60086	1·6642	·62486	1·6003	·64940	1·5398	60′
1	·60125	1·6631	·62527	1·5992	·64982	1·5388	59
2	·60165	1·6620	·62567	1·5982	·65023	1·5379	58
3	·60204	1·6609	·62608	1·5972	·65064	1·5369	57
4	·60244	1·6599	·62648	1·5961	·65106	1·5359	56
5	·60284	1·6588	·62689	1·5951	·65147	1·5349	55
6	·60323	1·6577	·62729	1·5941	·65189	1·5339	54
7	·60363	1·6566	·62770	1·5931	·65230	1·5330	53
8	·60403	1·6555	·62810	1·5920	·65272	1·5320	52
9	·60442	1·6544	·62851	1·5910	·65313	1·5310	51
10	·60482	1·6533	·62892	1·5900	·65355	1·5301	50
11	·60522	1·6522	·62932	1·5889	·65396	1·5291	49
12	·60562	1·6511	·62973	1·5879	·65438	1·5281	48
13	·60601	1·6501	·63013	1·5869	·65479	1·5271	47
14	·60641	1·6490	·63054	1·5859	·65521	1·5262	46
15	·60681	1·6479	·63095	1·5849	·65562	1·5252	45
16	·60721	1·6468	·63135	1·5838	·65604	1·5242	44
17	·60761	1·6457	·63176	1·5828	·65646	1·5233	43
18	·60800	1·6447	·63217	1·5818	·65687	1·5223	42
19	·60840	1·6436	·63258	1·5808	·65729	1·5213	41
20	·60880	1·6425	·63298	1·5798	·65771	1·5204	40
21	·60920	1·6414	·63339	1·5787	·65812	1·5194	39
22	·60960	1·6404	·63380	1·5777	·65854	1·5185	38
23	·61000	1·6393	·63421	1·5767	·65896	1·5175	37
24	·61040	1·6382	·63461	1·5757	·65937	1·5165	36
25	·61080	1·6371	·63502	1·5747	·65979	1·5156	35
26	·61120	1·6361	·63543	1·5737	·66021	1·5146	34
27	·61160	1·6350	·63584	1·5727	·66063	1·5137	33
28	·61200	1·6339	·63625	1·5717	·66104	1·5127	32
29	·61240	1·6329	·63666	1·5706	·66146	1·5117	31
30	·61280	1·6318	·63707	1·5696	·66188	1·5108	30
31	·61320	1·6307	·63747	1·5686	·66230	1·5098	29
32	·61360	1·6297	·63788	1·5676	·66272	1·5089	28
33	·61400	1·6286	·63829	1·5666	·66314	1·5079	27
34	·61440	1·6275	·63870	1·5656	·66356	1·5070	26
35	·61480	1·6265	·63911	1·5646	·66397	1·5060	25
36	·61520	1·6254	·63952	1·5636	·66439	1·5051	24
37	·61560	1·6244	·63993	1·5626	·66481	1·5041	23
38	·61600	1·6233	·64034	1·5616	·66523	1·5032	22
39	·61640	1·6223	·64075	1·5606	·66565	1·5022	21
40	·61680	1·6212	·64116	1·5596	·66607	1·5013	20
41	·61721	1·6201	·64157	1·5586	·66649	1·5003	19
42	·61761	1·6191	·64198	1·5576	·66691	1·4994	18
43	·61801	1·6180	·64239	1·5566	·66733	1·4984	17
44	·61841	1·6170	·64281	1·5556	·66775	1·4975	16
45	·61881	1·6159	·64322	1·5546	·66817	1·4966	15
46	·61922	1·6149	·64363	1·5536	·66859	1·4956	14
47	·61962	1·6138	·64404	1·5526	·66902	1·4947	13
48	·62002	1·6128	·64445	1·5516	·66944	1·4937	12
49	·62042	1·6117	·64486	1·5507	·66986	1·4928	11
50	·62083	1·6107	·64527	1·5497	·67028	1·4919	10
51	·62123	1·6096	·64569	1·5487	·67070	1·4909	9
52	·62163	1·6086	·64610	1·5477	·67112	1·4900	8
53	·62204	1·6076	·64651	1·5467	·67155	1·4890	7
54	·62244	1·6065	·64692	1·5457	·67197	1·4881	6
55	·62284	1·6055	·64734	1·5447	·67239	1·4872	5
56	·62325	1·6044	·64775	1·5437	·67281	1·4862	4
57	·62365	1·6034	·64816	1·5428	·67323	1·4853	3
58	·62406	1·6024	·64858	1·5418	·67366	1·4844	2
59	·62446	1·6013	·64899	1·5408	·67408	1·4834	1
60	·62486	1·6003	·64940	1·5398	·67450	1·4825	0
	Cotangent	Tangent	Cotangent	Tangent	Cotangent	Tangent	
	58 Degrees		57 Degrees		56 Degrees		

TABLE III.

	34 DEGREES		35 DEGREES		36 DEGREES		
	Tangent	Cotangt	Tangent	Cotangent	Tangent	Cotangent	
0′	·67450	1·4825	·70020	1·4281	·72654	1·3763	60
1	·67493	1·4816	·70064	1·4272	·72698	1·3755	59
2	·67535	1·4807	·70107	1·4263	·72743	1·3746	58
3	·67577	1·4797	·70150	1·4254	·72787	1·3738	57
4	·67620	1·4788	·70194	1·4246	·72832	1·3730	56
5	·67662	1·4779	·70237	1·4237	·72876	1·3721	55
6	·67705	1·4769	·70281	1·4228	·72921	1·3713	54
7	·67747	1.4760	·70324	1·4219	·72965	1·3705	53
8	·67789	1·4751	·70368	1·4210	·73010	1·3696	52
9	·67832	1·4742	·70411	1·4202	·73055	1·3688	51
10	·67874	1·4732	·70455	1·4193	·73099	1·3679	50
11	·67917	1·4723	·70498	1·4184	·73144	1·3671	49
12	·67959	1·4714	·70542	1·4175	·73188	1·3663	48
13	·68002	1·4705	·70585	1·4167	·73233	1·3654	47
14	·68045	1·4696	·70629	1·4158	·73278	1·3646	46
15	·68087	1·4686	·70673	1·4149	·73323	1·3638	45
16	·68130	1·4677	·70716	1·4140	·73367	1·3629	44
17	·68172	1·4668	·70760	1·4132	·73412	1·3621	43
18	·68215	1·4659	·70803	1·4123	·73457	1·3613	42
19	·68258	1·4650	·70847	1·4114	·73502	1·3605	41
20	·68300	1·4641	·70891	1·4106	·73546	1·3596	40
21	·68343	1·4632	·70935	1·4097	·73591	1·3588	39
22	·68386	1·4622	·70978	1·4088	·73636	1·3580	38
23	·68428	1·4613	·71022	1·4080	·73681	1·3571	37
24	·68471	1·4604	·71066	1·4071	·73726	1·3563	36
25	·68514	1·4595	·71110	1·4062	·73771	1·3555	35
26	·68556	1·4586	·71153	1·4054	·73816	1·3547	34
27	·68599	1·4577	·71197	1·4045	·73861	1·3538	33
28	·68642	1·4568	·71241	1·4036	·73906	1·3530	32
29	·68685	1·4559	·71285	1·4028	·73951	1·3522	31
30	·68728	1·4550	·71329	1·4019	·73996	1·3514	30
31	·68770	1·4541	·71373	1·4010	·74041	1·3506	29
32	·68813	1·4531	·71417	1·4002	·74086	1·3497	28
33	·68856	1·4522	·71461	1·3993	·74131	1·3489	27
34	·68899	1·4513	·71505	1·3985	·74176	1·3481	26
35	·68942	1·4504	·71548	1·3976	·74221	1·3473	25
36	·68985	1·4495	·71592	1·3967	·74266	1·3465	24
37	·69028	1·4486	·71636	1·3959	·74311	1·3456	23
38	·69071	1·4477	·71681	1·3950	·74356	1·3448	22
39	·69114	1·4468	·71725	1·3942	·74402	1·3440	21
40	·69157	1·4459	·71769	1·3933	·74447	1·3432	20
41	·69200	1·4450	·71813	1·3925	·74492	1·3424	19
42	·69243	1·4441	·71857	1·3916	·74537	1·3416	18
43	·69286	1·4432	·71901	1·3907	·74582	1·3407	17
44	·69329	1·4423	·71945	1·3899	·74628	1·3399	16
45	·69372	1·4414	·71989	1·3890	·74673	1·3391	15
46	·69415	1·4405	·72033	1·3882	·74718	1·3383	14
47	·69458	1·4397	·72078	1·3873	·74764	1·3375	13
48	·69501	1·4388	·72122	1·3865	·74809	1·3367	12
49	·69544	1·4379	·72166	1·3856	·74854	1·3359	11
50	·69588	1·4370	·72210	1·3848	·74900	1·3351	10
51	·69631	1·4361	·72255	1·3839	·74945	1·3342	9
52	·69674	1·4352	·72299	1·3831	·74991	1·3334	8
53	·69717	1·4343	·72343	1·3822	·75036	1·3326	7
54	·69760	1·4334	·72387	1·3814	·75082	1·3318	6
55	·69804	1·4325	·72432	1·3806	·75127	1·3310	5
56	·69847	1·4316	·72476	1·3797	·75173	1·3302	4
57	·69890	1·4308	·72521	1·3789	·75218	1·3294	3
58	·69934	1·4299	·72565	1·3780	·75264	1·3286	2
59	·69977	1·4290	·72609	1·3772	·75309	1·3278	1
60	·70020	1·4281	·72654	1·3763	·75355	1·3270	0
	Cotangent	Tangent	Cotangent	Tangent	Cotangent	Tangent	
	55 DEGREES		54 DEGREES		53 DEGREES		

TABLE III.

	37 Degrees		38 Degrees		39 Degrees		
	Tangent	Cotangent	Tangent	Cotangent	Tangent	Cotangent	
0'	·75355	1·3270	·78128	1·2799	·80978	1·2348	60'
1	·75401	1·3262	·78175	1·2791	·81026	1·2341	59
2	·75446	1·3254	·78222	1·2784	·81074	1·2334	58
3	·75492	1·3246	·78269	1·2776	·81123	1·2326	57
4	·75537	1·3238	·78316	1·2768	·81171	1·2319	56
5	·75583	1·3230	·78363	1·2761	·81219	1·2312	55
6	·75629	1·3222	·78410	1·2753	·81267	1·2304	54
7	·75675	1·3214	·78457	1·2745	·81316	1·2297	53
8	·75720	1·3206	·78504	1·2738	·81364	1·2290	52
9	·75766	1·3198	·78551	1·2730	·81412	1·2283	51
10	·75812	1·3190	·78598	1·2722	·81461	1·2275	50
11	·75858	1·3182	·78645	1·2715	·81509	1·2268	49
12	·75904	1·3174	·78692	1·2707	·81558	1·2261	48
13	·75949	1·3166	·78739	1·2700	·81606	1·2253	47
14	·75995	1·3158	·78786	1·2692	·81654	1·2246	46
15	·76041	1·3150	·78833	1·2684	·81703	1·2239	45
16	·76087	1·3142	·78880	1·2677	·81751	1·2232	44
17	·76133	1·3134	·78928	1·2669	·81800	1·2224	43
18	·76179	1·3126	·78975	1·2662	·81849	1·2217	42
19	·76225	1·3118	·79022	1·2654	·81897	1·2210	41
20	·76271	1·3111	·79069	1·2647	·81946	1·2203	40
21	·76317	1·3103	·79117	1·2639	·81994	1·2195	39
22	·76363	1·3095	·79164	1·2631	·82043	1·2188	38
23	·76409	1·3087	·79211	1·2624	·82092	1·2181	37
24	·76455	1·3079	·79259	1·2616	·82140	1·2174	36
25	·76501	1·3071	·79306	1·2609	·82189	1·2166	35
26	·76548	1·3063	·79353	1·2601	·82238	1·2159	34
27	·76594	1·3055	·79401	1·2594	·82287	1·2152	33
28	·76640	1·3047	·79448	1·2586	·82335	1·2145	32
29	·76686	1·3040	·79496	1·2579	·82384	1·2138	31
30	·76732	1·3032	·79543	1·2571	·82433	1·2130	30
31	·76778	1·3024	·79591	1·2564	·82482	1·2123	29
32	·76825	1·3016	·79638	1·2556	·82531	1·2116	28
33	·76871	1·3008	·79686	1·2549	·82580	1·2109	27
34	·76917	1·3000	·79733	1·2541	·82629	1·2102	26
35	·76964	1·2993	·79781	1·2534	·82678	1·2095	25
36	·77010	1·2985	·79828	1·2526	·82727	1·2087	24
37	·77056	1·2977	·79876	1·2519	·82776	1·2080	23
38	·77103	1·2969	·79924	1·2511	·82825	1·2073	22
39	·77149	1·2961	·79971	1·2504	·82874	1·2066	21
40	·77195	1·2954	·80019	1·2496	·82923	1·2059	20
41	·77242	1·2946	·80067	1·2489	·82972	1·2052	19
42	·77288	1·2938	·80115	1·2482	·83021	1·2045	18
43	·77335	1·2930	·80162	1·2474	·83070	1·2037	17
44	·77381	1·2922	·80210	1·2467	·83119	1·2030	16
45	·77428	1·2915	·80258	1·2459	·83169	1·2023	15
46	·77474	1·2907	·80306	1·2452	·83218	1·2016	14
47	·77521	1·2899	·80354	1·2444	·83267	1·2009	13
48	·77567	1·2891	·80402	1·2437	·83316	1·2002	12
49	·77614	1·2884	·80449	1·2430	·83366	1·1995	11
50	·77661	1·2876	·80497	1·2422	·83415	1·1988	10
51	·77707	1·2868	·80545	1·2415	·83464	1·1981	9
52	·77754	1·2860	·80593	1·2407	·83514	1·1974	8
53	·77801	1·2853	·80641	1·2400	·83563	1·1966	7
54	·77847	1·2845	·80689	1·2393	·83612	1·1959	6
55	·77894	1·2837	·80737	1·2385	·83662	1·1952	5
56	·77941	1·2830	·80785	1·2378	·83711	1·1945	4
57	·77988	1·2822	·80834	1·2371	·83761	1·1938	3
58	·78034	1·2814	·80882	1·2363	·83810	1·1931	2
59	·78081	1·2807	·80930	1·2356	·83860	1·1924	1
60	·78128	1·2799	·80978	1·2348	83909	1·1917	0
	Cotangent	Tangent	Cotangent	Tangent	Cotangent	Tangent	
	52 Degrees		51 Degrees		50 Degrees		

TABLE III.

	40 Degrees		41 Degrees		42 Degrees		
	Tangent	Cotangent	Tangent	Cotangent	Tangent	Cotangent	
0'	·83909	1·1917	·86928	1·1503	·90040	1·1106	60'
1	·83959	1·1910	·86979	1·1496	·90093	1·1099	59
2	·84009	1·1903	·87030	1·1490	·90145	1·1093	58
3	·84058	1·1896	·87082	1·1483	·90198	1·1086	57
4	·84108	1·1889	·87133	1·1476	·90251	1·1080	56
5	·84158	1·1882	·87184	1·1469	·90304	1·1073	55
6	·84207	1·1875	·87235	1·1463	·90356	1·1067	54
7	·84257	1·1868	·87286	1·1456	·90409	1·1060	53
8	·84307	1·1861	·87338	1·1449	·90462	1·1054	52
9	·84357	1·1854	·87389	1·1443	·90515	1·1047	51
10	·84406	1·1847	·87440	1·1436	·90568	1·1041	50
11	·84456	1·1840	·87492	1·1429	·90621	1·1034	49
12	·84506	1·1833	·87543	1·1422	·90674	1·1028	48
13	·84556	1·1826	·87594	1·1416	·90727	1·1022	47
14	·84606	1·1819	·87646	1·1409	·90780	1·1015	46
15	·84656	1·1812	·87697	1·1402	·90833	1·1009	45
16	·84706	1·1805	·87749	1·1396	·90886	1·1002	44
17	·84756	1·1798	·87800	1·1389	·90939	1·0996	43
18	·84806	1·1791	·87852	1·1382	·90993	1·0989	42
19	·84856	1·1784	·87903	1·1376	·91046	1·0983	41
20	·84906	1·1777	·87955	1·1369	·91099	1·0977	40
21	·84956	1·1770	·88006	1·1362	·91152	1·0970	39
22	·85006	1·1763	·88058	1·1356	·91205	1·0964	38
23	·85056	1·1756	·88110	1·1349	·91259	1·0957	37
24	·85106	1·1749	·88161	1·1342	·91312	1·0951	36
25	·85156	1·1743	·88213	1·1336	·91365	1·0945	35
26	·85207	1·1736	·88265	1·1329	·91419	1·0938	34
27	·85257	1·1729	·88317	1·1322	·91472	1·0932	33
28	·85307	1·1722	·88368	1·1316	·91526	1·0925	32
29	·85357	1·1715	·88420	1·1309	·91579	1·0919	31
30	·85408	1·1708	·88472	1·1302	·91633	1·0913	30
31	·85458	1·1701	·88524	1·1296	·91686	1·0906	29
32	·85508	1·1694	·88576	1·1289	·91740	1·0900	28
33	·85559	1·1687	·88628	1·1283	·91793	1·0893	27
34	·85609	1·1680	·88680	1·1276	·91847	1·0887	26
35	·85659	1·1674	·88732	1·1269	·91901	1·0881	25
36	·85710	1·1667	·88784	1·1263	·91954	1·0874	24
37	·85760	1·1660	·88836	1·1256	·92008	1·0868	23
38	·85811	1·1653	·88888	1·1250	·92062	1·0862	22
39	·85861	1·1646	·88940	1·1243	·92115	1·0855	21
40	·85912	1·1639	·88992	1·1266	·92169	1·0849	20
41	·85962	1·1632	·89044	1·1230	·92223	1·0843	19
42	·86013	1·1626	·89096	1·1223	·92277	1·0836	18
43	·86064	1·1619	·89148	1·1217	·92331	1·0830	17
44	·86114	1·1612	·89201	1·1210	·92385	1·0824	16
45	·86165	1·1605	·89253	1·1204	·92439	1·0817	15
46	·86216	1·1598	·89305	1·1197	·92493	1·0811	14
47	·86266	1·1591	·89357	1·1190	·92547	1·0805	13
48	·86317	1·1585	·89410	1·1184	·92601	1·0799	12
49	·86368	1·1578	·89462	1·1177	·92655	1·0792	11
50	·86419	1·1571	·89515	1·1171	·92709	1·0786	10
51	·86470	1·1564	·89567	1·1164	·92763	1·0780	9
52	·86520	1·1557	·89619	1·1158	·92817	1·0773	8
53	·86571	1·1551	·89672	1·1151	·92871	1·0767	7
54	·86622	1·1544	·89724	1·1145	·92925	1·0761	6
55	·86673	1·1537	·89777	1·1138	·92979	1·0755	5
56	·86724	1·1530	·89829	1·1132	·93034	1·0748	4
57	·86775	1·1523	·89882	1·1125	·93088	1·0742	3
58	·86826	1·1517	·89935	1·1119	·93142	1·0736	2
59	·86877	1·1510	·89987	1·1112	·93197	1·0729	1
60	·86928	1·1503	·90040	1·1106	·93251	1·0723	0
	Cotangent	Tangent	Cotangent	Tangent	Cotangent	Tangent	
	49 Degrees		48 Degrees		47 Degrees		

	43 Degrees		44 Degrees		
	Tangent	Cotangent	Tangent	Cotangent	
0′	·93251	1·0723	·96568	1·0355	60′
1	·93305	1·0717	·96625	1·0349	59
2	·93360	1·0711	·96681	1·0343	58
3	·93414	1·0704	·96737	1·0337	57
4	·93469	1·0698	·96793	1·0331	56
5	·93523	1·0692	·96850	1·0325	55
6	·93578	1·0686	·96906	1·0319	54
7	·93632	1·0680	·96963	1·0313	53
8	·93687	1·0673	·97019	1·0307	52
9	·93742	1·0667	·97076	1·0301	51
10	·93796	1·0661	·97132	1·0295	50
11	·93851	1·0655	·97189	1·0289	49
12	·93906	1·0648	·97245	1·0283	48
13	·93961	1·0642	·97302	1·0277	47
14	·94015	1·0636	·97359	1·0271	46
15	·94070	1·0630	·97415	1·0265	45
16	·94125	1·0624	·97472	1·0259	44
17	·94180	1·0617	·97529	1·0253	43
18	·94235	1·0611	·97585	1·0247	42
19	·94290	1·0605	·97642	1·0241	41
20	·94345	1·0599	·97699	1·0235	40
21	·94400	1·0593	·97756	1·0229	39
22	·94455	1·0587	·97813	1·0223	38
23	·94510	1·0580	·97870	1·0217	37
24	·94565	1·0574	·97927	1·0211	36
25	·94620	1·0568	·97984	1·0205	35
26	·94675	1·0562	·98041	1·0199	34
27	·94730	1·0556	·98098	1·0193	33
28	·94785	1·0550	·98155	1·0187	32
29	·94841	1·0543	·98212	1·0181	31
30	·94896	1·0537	·98269	1·0176	30
31	·94951	1·0531	·98326	1·0170	29
32	·95007	1·0525	·98384	1·0164	28
33	·95062	1·0519	·98441	1·0158	27
34	·95117	1·0513	·98498	1·0152	26
35	·95173	1·0507	·98556	1·0146	25
36	·95228	1·0501	·98613	1·0140	24
37	·95284	1·0494	·98670	1·0134	23
38	·95339	1·0488	·98728	1·0128	22
39	·95395	1·0482	·98785	1·0122	21
40	·95450	1·0476	·98843	1·0117	20
41	·95506	1·0470	·98900	1·0111	19
42	·95562	1·0464	·98958	1·0105	18
43	·95617	1·0458	·99015	1·0099	17
44	·95673	1·0452	·99073	1·0093	16
45	·95729	1·0446	·99131	1·0087	15
46	·95784	1·0440	·99188	1·0081	14
47	·95840	1·0433	·99246	1·0075	13
48	·95896	1·0427	·99304	1·0070	12
49	·95952	1·0421	·99362	1·0064	11
50	·96008	1·0415	·99419	1·0058	10
51	·96064	1·0409	·99477	1·0052	9
52	·96120	1·0403	·99535	1·0046	8
53	·96176	1·0397	·99593	1·0040	7
54	·96232	1·0391	·99651	1·0034	6
55	·96288	1·0385	·99709	1·0029	5
56	·96344	1·0379	·99767	1·0023	4
57	·96400	1·0373	·99825	1·0017	3
58	·96456	1·0367	·99883	1·0011	2
59	·96512	1·0361	·99941	1·0005	1
60	·96568	1·0355	1·0000	1·0000	0
	Cotangent	Tangent	Cotangent	Tangent	
	46 Degrees		45 Degrees		

TABLE IV.

ANGLES, RADII, AND DISTANCES FOR RAILWAY CROSSINGS.

Pitch of Crossing	Angle		Radius	Distance of Point of Switch from Point of Crossing		Cross-over Road Distance of Point of Switch from Point of Recurvature, or Half-length of Road		
						For 6 feet between Roads	For 7 feet between Roads	For 8 feet between Roads
	Deg.	Min.	Feet	Ft.	In.	Feet	Feet	Feet
1 in 5	11	26	237	47	0	51	53	55
1 in 6	9	32	341	56	7	61	64	67
1 in 7	8	10	464	65	10	72	75	78
1 in 8	7	10	603	75	2	82	85	89
1 in 9	6	21	768	84	11	92	96	100
1 in 10	5	44	938	93	8	102	106	111
1 in 12	4	46	1361	113	1	123	129	135

SETTING OUT CURVES WITHOUT A THEODOLITE,

ON THE PRINCIPLE OF TANGENTIAL ANGLES, BY TANGENTS AND CORRESPONDING OFFSETS, CALCULATED FOR FIELD USE FROM THE SINES AND VERSINES OF THE ANGLES AT THE CENTRE.

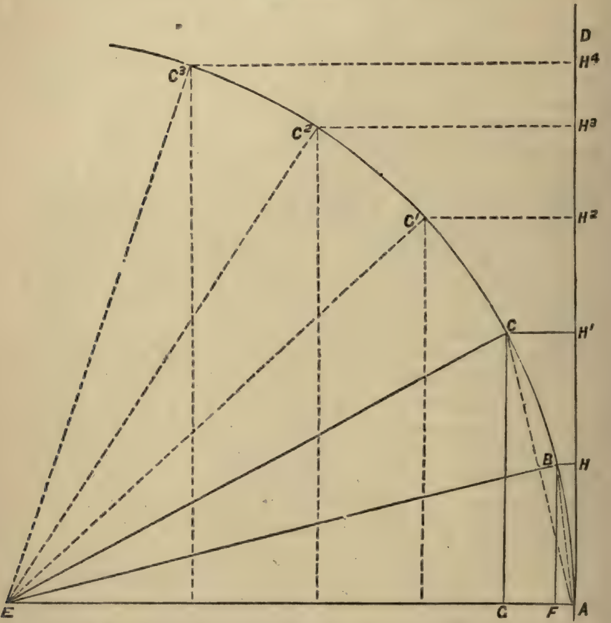
To MANY, even good practical engineers, there is an insuperable objection to the use of the Theodolite. For the purpose of setting out curves without this instrument, the annexed tables have been calculated, so that the work may be done on the principle of tangents and tangential angles, merely by setting off the offsets from given distances on the tangents, such distances corresponding to the proper chainage on the curve. There are many engineers who still adhere to the old, *very old,* system of ranging curves by short chords of a chain in length, and then offsetting to the curve, and thus bending round at the length of every chain; but all those who have actually done much field work, know how tedious and uncertain the system, and no one better than the writer, who used it some twenty-five years ago, in setting out many miles of curves in a very hilly country. The tables here given do away with all uncertainty, and the work may be done rapidly and with accuracy.

In the accompanying diagram, p. 146, let A B represent a chain's length on any circular curve, and let B C be a second chain's length on such curve; let D A be tangent to the curve at the point A, and let E be the centre of the curve. The angle at the centre B E A is equal to twice the angle B A D, and, similarly, the angle C E A is equal to twice the angle C A D; B F is the sine of the angle B E A, and F A is the versine of the same angle; and C G is the sine of the angle C E A, of which G A is the versine.

The sines B F and C G are parallel to the tangent A D, and the versines F A and G A are at right-angles to A D.

On A D, set off A H, equal to F B, and also H^1, equal to G E; now, if from H we set off the right-angled offset H B, equal to A F, and from H^1, the right-angled offset H^1 C, equal to A G, we get two points on the curve, viz., B and C, each one chain's length from the other; for B A and C A are each equal to one chain. In the right-angled parallelogram B A, B H is equal to the versine F A of the angle B E A; and also in the right-angled parallelogram C A, H' C is equal to the versine A G of the angle C E A. Any other number of points on the curve might have been obtained in the same manner. In the tables here given, the tabular 'tangents' all correspond to AH, AH^1, AH^2, and AH^3, &c.; and the tabular offsets all correspond to HB, H^1C; H^2C^1, H^3C^2, for different radii of curves, and for points along the curve distant half a chain each from each, so that a curve of any radius given in the tables may set out on the ground, without theodolite, with the greatest facility and with perfect accuracy by

Fig. 1.



any one who can chain with care and set off a right-angled offset, both simple operations, which even a good ganger is perfectly competent to accomplish, so that, with the tangent starting point, and the direction of the tangent being given on the ground, much time may often be saved.

As an example, we will take a curve of 10 chains radius;—referring still to the last figure, and to Table IV., let AB be the first chain, BC the second, and CC^1 the third chain, &c. &c.; leaving the half chains out of the question for the present, we find the length of the first tangent to be 99·8, to which make AH equal; make AH^1 equal to 198·6, the length of the next tangent in the table;—chaining still on in the direction AD, make

AH^2 equal to 295·5 for the length of tangent for the third chain H^2, and then on to H^3, leaving a mark at 389·4 for the fourth chain at H^3, &c., &c.

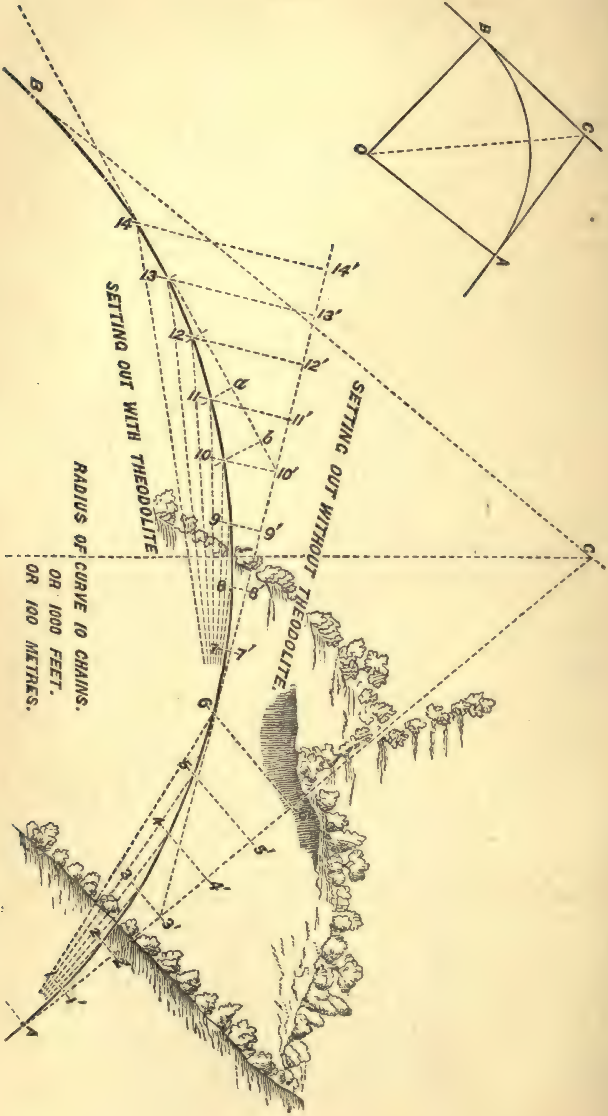
Referring now to the column of offsets, make H B equal to 5·0 links, which will give the length and direction of the first chain A B;— from H^1 set off H^1 C at right angles to A D, and make H^1 C equal to 19·9 links; this will give the length and the direction of the second chain H^1 C. In the next place, from H^2 set off H^2 C^1 at right-angles to A D; from the column of offsets in the table, take out 44·7, the length of the offset due to the third chain, to which make H^2 C^1 equal; this will give the length and the direction of the third chain C C^1, and so on until we change the direction of the tangent. We now come to the operation of setting out a curve from one tangent to the other, as shown in fig. 2 on the next page, in which we will suppose the radius of the curve to be still ten chains. It may be observed here, as regards the actual meaning of the words 'chain,' and 'link,' that the length of chain may be 100 feet, or 100 links = 66 feet, or 100 decimetres, it being only necessary, according as we are working on one or the other system, to have a chain of the proper length, and a ten feet, ten link, or ten decimetre rod, with each unit properly divided into tenths, so as to be able to do the work with sufficient accuracy. If, for instance, we have a ten 'chain' curve, then we shall use the ordinary 66 feet chain and a ten link staff, properly divided; and if we have a curve of 1,000 feet radius, then we shall use the 100 feet chain, and a ten feet staff divided into feet and tenths, &c., &c.

In the figure now referred to, it will be seen that it is here proposed to illustrate the two methods of setting out, that is, with and without theodolite, both systems being applications of practical mathematics in the field: in the one system we set out by angles and chords, and in the other by the lineal measurements of the angles only; both systems will bring about exactly the same results if properly carried out. Commencing, then, at the very beginning of the work, we measure the angle A C B, and divide it by 2, which gives the angle A C O; deduct this from 90° and we get the angle C O A, to which A C is the tangent.

Let the angle B C A measure 79° − 36′, half of which is 39° − 48′, equal to O C A; subtract this from 90°, and we shall have 50° − 12′, equal to the angle C O A, to which C A is the tangent. The first point we require is A; to find this we take out from Table III. the natural tangent of 50° − 12′, which is 1·2002; this, multiplied by the radius of the curve, gives the length of C A, which, measured off from C, fixes the point A; in the present case, 1·2002, multiplied by 10, gives 12·002, which, measured off along the tangent C A, fixes the point A.

This preliminary settled, we may proceed with our work of setting out. The direction of A C having been carefully determined already, we have only to chain on from A to 1′, equal to 99·8, leaving there some small pig. (as of course we are supposed to do all along), and on to 2′, equal to 198·6, and to 3′, equal to 295·5, ... and so on to 6′, equal to

Fig. 2.

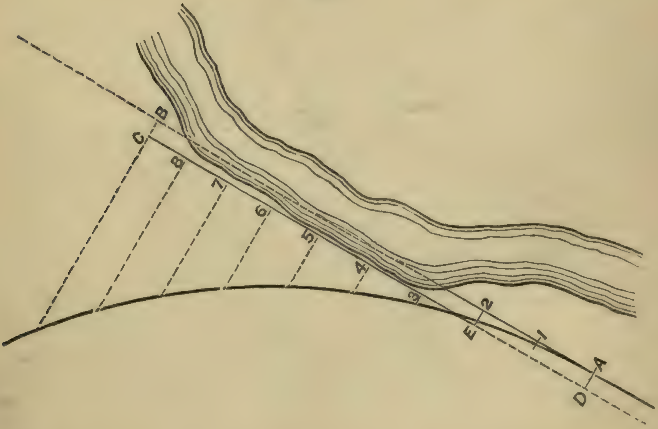

B
C
O
A
B
A
a
b
C
SETTING OUT WITH THEODOLITE
SETTING OUT WITHOUT THEODOLITE.
RADIUS OF CURVE 10 CHAINS.
OR 1000 FEET.
OR 100 METRES.

564·6. We are here getting into obstructions of bushes and broken ground, and we will therefore set out a new tangent. Before doing this, however, we must set out the offsets which will determine the points on the curve.

From 1′ set out 1′1, equal to 5·0; from 2′ set out 2′2, equal to 19·9; from 3′ set out 3′3, equal to 44·7; . . . . . and so on to 6′, where the offset 6′6 will be 174·5. It will be unnecessary to observe that the line A 6′ must be chained perfectly straight, and in line with the tangent A C, of which it forms a part, and that each point must be carefully set out at its correct length; also that the offsets must be set off perfectly square to the tangent, which should be done with the cross-staff, and, of course, that the length must be accurately set out.

With regard to turning the straight line, or getting a new tangent: the setting out has been stopped at the 6th chain, then set the cross-staff on the last tangent at 3′, and through the point 6 sight out the line from 3′, through 6, on and beyond 14′, according to the distance we intend to run out. The chaining is now to be recommenced from the point 6; 6, 7′, is made equal to 99·8; 6, 8′, is made equal to 198·6; 6, 9′, is made equal to 295·5; . . . . and so on until we get to 14′, where the length is made equal to 717·4. The tabular offsets are set off in the same manner as already explained, until we get to 14′, 14, where the length of offset is 235·2.

Fig. 3.

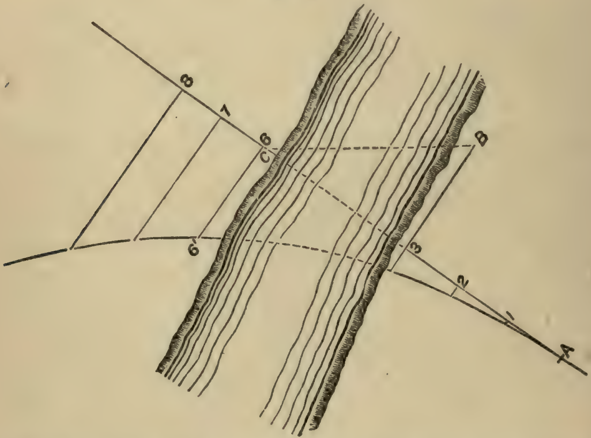


Here we propose again to set out a new tangent, and this is done in the same way as we did it last; this time, however, we have set out 8 additional chains on the curve, therefore set up the cross-staff at 10′, and sight the new tangent through the point marked 14.

It is, of course, understood that the measurements given above, for the lengths of tangents and offsets, are taken from the tabular numbers given in the columns of tangents and of offsets in the Table, prepared for a 10 chain curve, and that these tabular numbers have all been calculated from the sines and versines of the angles at the centre of the curve.

It is a very common occurrence, when setting out work, to meet with obstructions on the ground. We have an illustration at fig. 3, where the tangent runs into and along the bank of a river. Set out the work from 1 and 2 as before, and from A, set out A D exactly at right-angles to the tangent, and make A D some 8 or 10 feet, as convenient; in the next place, from any point B (carefully sighted on the tangent), set off B C, exactly equal to A D; from 2 set off 2 E, exactly equal to A D and to B C; set up the cross-staff at D, and see that D, E, and C are all three exactly in line. From point E we can now set off from E to 3, 4, 5, &c.; the offsets set off from these points will merely be 8 or 10 feet shorter than they would have been otherwise. If the cross-staff is true, and the work is carefully done, there will be no error. This method may also be adopted where the tangent runs along, or on the wrong side of a fence.

Fig. 4.



In fig. 4, we have an illustration of a case requiring even more care than the last. Both the curve and the tangent run for 2 or 3 chains across a river. From 1, 2, and 3, set out the offsets as before. From 3 set out 3 B, exactly at right angles to A 8, and observe both the angles B 3 A and B 3 8 to ensure that B 3 is really square to the tangent, as otherwise the work will be valueless. Make 3 B some 2 or 3 full chains long, so that it may be somewhere about equal to 3 C. Having done this, measure the angle 3 B C with the box sextant; enter the observation in the field book, and then measure the angle 3 C B: the two together should make up 90°; if otherwise, the work has been badly done.

Let the angle 3 B C measure 52° – 26′, and let 3 B be exactly 2 chains. From p. 141 (Table III.), take out the natural tangent of 52° – 26′, equal to 1·300, and multiply it by 2, and we shall have 260 for the exact length of the line 3 C.

Now, let us suppose that we are setting out a 15 chain curve. By referring to the proper Table, it will be found that for A 3, the length of the tangent set out, we have 298, which, added to the above 260, gives 558 for the length from A to C. The next chainage on our tangent is, by the Table, equal to 584·1, and the difference between this and 558 is equal to 26·1; and if on the ground we set out this 26·1 in continuation from C, we get the point 6, from which we may set off the offset due to the curve, which is 118·4. Through 3 and 6′, we shall be able to set out a fresh tangent.

The theory of setting out curves by tangential angles, or by the offsets given in the Tables, is very simple; but in practice, some discretion is required in applying the theory, so as to obtain the best results in the easiest way.

In setting out with the theodolite, it is very desirable not to have to remove the instrument oftener than is absolutely necessary, and therefore stations should be selected, from which as many stumps as possible may be set out at once.

In the subjoined figure, p. 152, we select a case in point. Curves generally run along the sides of hills, so as to diminish the depths of cuttings and heights of embankments; in the example given, we suppose the line to be in cutting. Let A and D be the points of junction with the tangents, A being the point from which the curve is to be run towards D. Now it will be perceived that A is at the foot of the hill, and that there are five hedges to intersect, each of which will considerably impede the view, if the instrument be set up at A, unless gaps are cut for every stump to be set out; and this kind of work always occasions a great deal of loss of time, unless very tall ranging rods are used, which we object to, because they are never held sufficiently upright.* But if, instead of being in the hollow at A, the instrument were placed on high ground, we should be able to look back, and down upon the work, so as to see over the hedges. If, for instance, the instrument were placed at B, at the higher ground-level, not only should we be able to do this, but obtain also an unimpeded view towards D, and thus, after fixing the point B, range out the whole of the curve from one single point.

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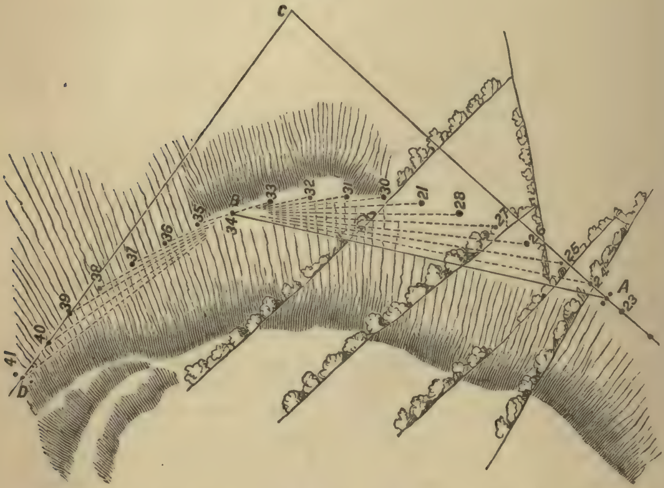
* The writer, in his practice of setting out works, hardly ever uses ranging rods, but prefers short pieces of white lath, which he always intersects *close to the ground* with the cross-hairs of the diaphragm of the theodolite.

From the plan we take into the field, we can easily ascertain whether this point, B, is at 8, 9, or 10 chains on the curve — it does not matter which. We will suppose that we select the 10th chain, and what we have now to do is to fix the point B, on the ground, from the point of junction A, which is at, say, 23 chains and 60 links.

Now if from this point we can set out the line A B correctly in length and direction, point B will be correctly fixed on the ground. Since the junction, A, is at 23·60, the length of curve, from A to B, should be exactly 10·40.

Fig. 5.



For a curve of ten chains radius, the tangential angle for 1 chain is equal to 2° 51·9′ (Table III., p. 120); then for a length of 10·40 on the curve, the angle C A B, to be set out, will be 2° 51·9′ × 10·40 = 29° 47·6′. This angle will accurately fix the direction A B; therefore set up the theodolite at A, and set out this angle of 29° 47·6′; and as, in doing this, we shall be working from right to left on the instrument, the reading on the limb will be 360°0′ minus 29° 47·6′, equal to 330° 12·4′ — the instrument being set up with O in the direction of C. We now want the length of the straight line A B, which is the chord of that portion of the curve. Now, the chord of an angle, or arc, is equal to twice the sine of half the angle subtended by such arc, or chord; and the angle at the centre, which is the angle subtended by our arc or portion of curve B A, is equal to twice the angle 29° 47·6′, and we have therefore to take twice the sine of this angle. At page 83, we find the sine of 29°47′ = ·49672, and for 29°48′ = ·49697; the mean of which (more than near enough for our work) will be ·49684, equal to the sine of our tangential angle, or to the sine of half the angle subtended by the arc or chord; and twice this sine multiplied by 2 equal to ·99368, and this multiplied by the ten-chain radius of curve, equal to 993·68, 993 links and $\frac{3}{4}$. According to the care observed in chaining this distance, or the line A B, so will the point B be more or less accurately set out on the curve; and as from this single point, the 18 stumps on the curve may all be set out without removing the instrument, it is worth while to measure out this distance as carefully as possible.

We will therefore suppose this portion of the work accomplished, and only further remark that it may be carefully carried out in the field in a much shorter time than it will take to read this explanation, when once the method is well understood. The half-chains have been left out in order to avoid confusion in the diagram, but for sharp curves these should always be set out.

The instrument may now be removed to point B, with the vernier clamped to 29° 47·6′, and the telescope turned on to A. The tangential angle, 2° 51·9′ × ·40 (the distance from point A to stump 24), equal to 1° 8·7′, and this deducted from 29° 47·6′ equal to 28° 38·9′, which is the reading for 10 chains (page 120), equal to the distance on the curve, from B to 24. To this angle therefore the instrument is set, and peg 24 driven at the end of the chain from 23 to 24; the instrument will now be set at 27° 13′ (9$\frac{1}{2}$ chains), and peg 24$\frac{1}{2}$ driven at the end of 24$\frac{1}{2}$ chains. The vernier is next set at 25° 47′ (9 chains), and peg 25 driven in line with the centre of the telescope and at the end of chain from 24 to 25. The vernier is next made to read 24° 21′ (8$\frac{1}{2}$ chains), and peg 25$\frac{1}{2}$ is driven in the line pointed out by the instrument, and at the end of 25$\frac{1}{2}$ chains, &c., until we come to reading 1° 25·9′, which will fix the stump between 33 and 34; and finally the vernier is brought to zero, which will fix the direction of the tangent to the curve at the point B.

The telescope is now reversed, or turned over in its standards to set out the remainder of the curve. We are now going to read from right to left, and we take the column headed 'Left-hand Reading.' The first tabular number is 358° 34·1′ ($\frac{1}{2}$ chain), and this will fix the peg at 34$\frac{1}{2}$ chains; the next reading is 357° 8·1′ (1 chain), which will fix the direction at the end of 35th chain, and so on to the end of the curve.

It will very often be found convenient to set out the whole of a curve with the theodolite from a single point in the middle of a curve, which may be done in the following manner.

Referring to the diagrams at p. 148, it will be seen that C O is the secant to either of the equal angles A O C, B O C; multiply the radius of curve by this natural secant, deduct radius, and the remainder will be the distance from C, the intersection of the tangents, to the middle of the curve; set up the instrument at C, and lay out a line in the direction C O, by dividing the angle A C B exactly in two; on C O, set off the distance found, from C to the middle of the curve. This part of the work may be very accurately tested, for each of the angles of deflection from the middle of the curve to the tangential points A and B, should be found equal each to each, and their sum should be equal to the total angle of deflection A C B, equal to half the external angle at C, which has always to be measured in order to set out the points A and B, from which the curve begins to deflect from each of the tangents.

The total angle of deflection, C A B, divided by the tangential angle for 1 chain, is equal to the length of the curve. We have now all that is required to enable us on many occasions to range from the middle of the curve every stump towards A and B. As an example, let the radius of a curve to be set out $=20$ chains; angle of deflection C A B, equal to half the external angle at C, $=25^\circ-21'{\cdot}226$, half of which equal to $12^\circ-40'{\cdot}613=$ angle of deflection from the middle of the curve to either point of junction, A or B.

Tangential angle for 1 chain $=\frac{1718{\cdot}9}{20}=1^\circ-25'{\cdot}945$, and $\frac{12^\circ-40'{\cdot}613}{1^\circ-25'{\cdot}945}$ $=8{\cdot}85$ chains $=$ half length of curve.

Let the distance from the last full chain stump to the commencement of curve measure 60 links; then we shall have 40 links of curve up to the next full chain stump, and the half length of curve $=8{\cdot}85-(0{\cdot}40+8)$ $=0{\cdot}45=$ the distance from point 8 to the middle of the curve.

The tangential angle due to 40 links $=85'{\cdot}945\times0{\cdot}40=0^\circ-34'{\cdot}4$.

" " " 8 chains . . . $=11^\circ-27'{\cdot}56$,

the sum of which, deducted from the above $12^\circ-40'{\cdot}613$, will leave $38'{\cdot}6$ for the tangential angle due to the 45 links from point 8 to the middle of the curve.

Now plant the theodolite at the point ascertained as the middle of the curve, set the vernier to the angle of $12^\circ-40'{\cdot}5$, and bring the glass to bear on the stump at the commencement of the curve; unclamp and set to $12^\circ-6'{\cdot}2$ $(12^\circ-40'{\cdot}6-34'{\cdot}4)$ for the next stump, and then to $10^\circ-40'{\cdot}2$, for the following stump; and so on to the end of the curve.

TABLE V.

TABLE FOR SETTING OUT CURVES WITHOUT THEODOLITE, ON THE PRINCIPLE OF TANGENTIAL ANGLES, BY TANGENTS AND CORRESPONDING OFFSETS, CALCULATED FOR PRACTICAL FIELD USE, FROM THE SINES AND VERSINES OF THE ANGLES AT THE CENTRES OF THE CURVES.

TABLE V. FOR SETTING OUT CURVES BY OFFSETS AND WITHOUT THEODOLITE
FOR THE 66 FEET OR 100 FEET CHAIN.

4 CHAINS RADIUS.

	° ′
Tangential angle for 1 chain	7—9·7
Angle at centre ,, ,,	14—19·4
Sine of angle at centre ,,	·24740
Versine ,, ,, ,,	·03109

Chains	Tangents	Offsets
	Links	Links
½	49·9	3·1
1	98·9	12·4
1½	146·5	27·8
2	191·8	48·8
2½	234·0	75·6
3	272·6	107·3
3½	307·0	143·6
4	336·6	183·9
4½	360·9	227·5
5	379·6	273·8

5 CHAINS RADIUS.

	° ′
Tangential angle for 1 chain	5—43·7
Angle at centre ,, ,,	11—27·5
Sine of angle at centre ,,	·19865
Versine ,, ,, ,,	·01993

Chains	Tangents	Offsets
	Links	Links
½	49·9	2·5
1	99·3	9·9
1½	147·7	22·3
2	194·7	39·4
2½	239·7	61·2
3	282·3	87·3
3½	322·1	117·6
4	348.4	141·3
4½	391·6	189·2
5	420·7	229·8

Note.—To avoid confusion between decimals of chains and decimals of links, the readings are all entered as links and decimals: thus, 1 chain, 91 links, and eight-tenths, is entered as 191·8 links; the links may be either of feet, of 7·92 inches, or of decimetres, &c.; it is sufficient that the chain be a decimal part of the radius of curve.

TABLE V. FOR SETTING OUT CURVES BY OFFSETS AND WITHOUT THEODOLITE FOR THE 66 FEET OR 100 FEET CHAIN.

6 CHAINS RADIUS.

	° ′
Tangential angle for 1 chain	44—6·5
Angle at centre " "	9—32·9
Sine of angle at centre "	·16588
Versine " " "	·01386

7 CHAINS RADIUS.

	° ′
Tangential angle for 1 chain	4—5·5
Angle at centre " "	8—11·1
Sine of angle at centre "	·14234
Versine " " "	·01018

Chains	Tangents	Offsets	Chains	Tangents	Offsets
	Links	Links		Links	Links
½	49·9	2·1	½	49·9	1·8
1	99·5	8·3	1	99·6	7·1
1½	148·4	18·6	1½	148·8	16·0
2	196·3	33·0	2	197.2	28·4
2½	242·8	51·3	2½	244·7	44·2
3	287·7	73·5	3	290·9	63·3
3½	330·5	99·2	3½	355.6	87·7
4	371·0	128·5	4	378·5	111·2
4½	409·0	161·0	4½	419·6	139·7
5	444·1	196·5	5	458·5	171·1
5½	476·1	234·9	5½	495·1	205·0
6	517·9	297·1	6	529·1	241·8
6½	530·1	318·9	6½	560·5	280·7
7	551·5	364·0	7	589·0	321·7

TABLE V. FOR SETTING OUT CURVES BY OFFSETS AND WITHOUT THEODOLITE FOR THE 66 FEET OR 100 FEET CHAIN.

8 CHAINS RADIUS.

	° ′
Tangential angle for 1 chain.	3 – 34·8
Angle at centre " "	7 – 9·7
Sine of angle at centre "	·12467
Versine " " "	·00780

9 CHAINS RADIUS.

	° ′
Tangential angle for 1 chain	3 – 11·0
Angle at centre " "	6 – 22·0
Sine of angle at centre "	·11089
Versine " " "	·00617

8 CHAINS RADIUS.			9 CHAINS RADIUS.		
Chains	Tangents	Offsets	Chains	Tangents	Offsets
	Links	Links		Links	Links
½	49·9	1·5	½	49·9	1·4
1	99·7	6·2	1	99·8	5·5
1½	149·1	14·0	1½	149·3	12·5
2	197·2	24·8	2	198·2	22·2
2½	245·9	38·7	2½	246·8	34·5
3	261·0	55·6	3	294·5	49·5
3½	338·9	75·3	3½	341·3	67·2
4	383·5	97·9	4	387·0	87·4
4½	426·6	123·2	4½	431·5	110·2
5	468·1	151·2	5	474·7	135·3
5½	507·7	181·7	5½	516·4	162·9
6	545·3	214·6	6	556·5	192·7
6½	580·7	248·9	6½	594·9	224·7
7	614·0	287·2	7	631·5	258·8

TABLE V. FOR SETTING OUT CURVES BY OFFSETS AND WITHOUT THEODOLITE FOR THE 66 FEET OR 100 FEET CHAIN.

10 CHAINS RADIUS.

	° ′
Tangential angle for 1 chain . . .	2 – 51·9
Angle at centre „ „	5 – 43·8
Sine of angle at centre „	·09984
Versine „ „ „	·00497

Chains	Tangents	Offsets
	Links	Links
½	49·9	1·2
1	99 8	5·0
1½	149·5	11·2
2	198·6	19·9
2½	247·4	31·1
3	295·5	44·7
3½	342·9	60·6
4	389·4	78·9
4½	435·0	99·5
5	479·5	122·4
5½	522·7	147·5
6	564·6	174·5
6½	605·2	203·9
7	644·2	235·2
7½	681·6	268·3
8	717·4	303·3

15 CHAINS RADIUS.

	° ′
Tangential angle for 1 chain . . .	1 – 54·6
Angle at centre „ „	3 – 49·2
Sine of angle at centre „	·06656
Versine „ „ „	·00222

Chains	Tangents	Offsets
	Links	Links
½	49·9	0·8
1	99·9	3·3
1½	149·7	7·5
2	199·4	13·3
2½	248·8	20·8
3	298·0	29·9
3½	346·7	40·6
4	395·2	53·0
4½	443·3	67·0
5	490·8	82·6
5½	537·6	99·7
6	584·1	118·4
6½	627·8	138·6
7	674·8	160·4
7½	719·1	183 6
8	762·6	208·1

TABLE V. FOR SETTING OUT CURVES BYOFFSETS AND WITHOUT THEODOLITE FOR THE 66 FEET OR 100 FEET CHAIN.

20 CHAINS RADIUS.

	° ′
Tangential angle for 1 chain	1—25·9
Angle at centre „ „	2—51·9
Sine of angle at centre „	·04998
Versine „ „ „	·00125

25 CHAINS RADIUS.

	° ′
Tangential·angle for 1 chain	1—8·1
Angle at centre „ „	2—17·5
Sine of angle at centre „	·03998
Versine „ „ „	·00089

20 CHAINS RADIUS.			25 CHAINS RADIUS.		
Chains	Tangents	Offsets	Chains	Tangents	Offsets
	Links	Links		Links	Links
½	49·9	0·6	½	49·9	0·5
1	99·9	2·5	1	99·9	2·0
1½	149·8	5·6	1½	149·8	4·5
2	199·7	10·0	2	199·7	8·0
2½	249·4	15·6	2½	249·5	12·5
3	298·7	22·4	3	299·3	18·0
3½	348·1	30·5	3½	348·9	24·4
4	397·3	39·8	4	398·3	31·9
4½	446·2	50·4	4½	447·6	40·4
5	494·8	62·2	5	496·6	49·8
5½	543·2	75·1	5½	545·6	60·3
6	591·0	89·3	6	594·2	71·6
6½	638·6	104·7	6½	642·6	84·1
7	685·7	121·3	7	690·9	97·3
7½	732·5	139·0	7½	738·8	111·6
8	778·8	157·8	8	786·3	126·9

TABLE V. FOR SETTING OUT CURVES BY OFFSETS AND WITHOUT THEODOLITE FOR THE 66 FEET OR 100 FEET CHAIN.

30 CHAINS RADIUS.	° ′	35 CHAINS RADIUS.	° ′
Tangential angle for 1 chain	0—573	Tangential angle for 1 chain	0—49·1
Angle at centre ,, ,, ...	1—54·6	Angle at centre ,, ,, ...	1—38·2
Sine of angle at centre ,, ...	·03330	Sine of angle at centre ,, ...	·02856
Versine ,, ,, ,, ...	·00055	Versine ,, ,, ,, ...	·00041

Chains	Tangents	Offsets	Chains	Tangents	Offsets
	Links	Links		Links	Links
½	49·9	0·3	½	49·9	0·3
1	99·9	1·6	1	99·9	1·4
1½	149·8	3·7	1½	149·9	3·2
2	199·8	6·6	2	199·8	5·7
2½	249·7	10·4	2½	249·7	8·9
3	299·5	15·0	3	299·7	12·9
3½	349·2	20·4	3½	349·4	17·5
4	398·8	26·6	4	399·1	22·8
4½	448·3	33·7	4½	448·8	28·9
5	497·7	47·6	5	498·2	35·6
5½	546·9	50·2	5½	547·7	43·1
6	595·9	59·8	6	597·0	51·3
6½	644·9	71·2	6½	646·3	60·2
7	693·6	81·3	7	695·3	69·9
7½	742·2	93·3	7½	744·1	80·0
8	790·5	106·1	8	793·0	91·0

TABLE V. FOR SETTING OUT CURVES BY OFFSETS AND WITHOUT THEODOLITE FOR THE 66 FEET OR 100 FEET CHAIN.

40 CHAINS RADIUS.

	° ′
Tangential angle for 1 chain	0–43·0
Angle at centre " "	1–25·9
Sine of angle at centre "	·02498
Versine " " "	·00031

Chains	Tangents	Offsets
	Links	Links
½	49·9	0·3
1	99·9	1·2
1½	149·9	2·8
2	199·9	5·0
2½	249·7	7·8
3	299·7	11·3
3½	349·5	15·3
4	399·4	19·9
4½	449·0	25·3
5	498·7	31·1
5½	548·3	38·5
6	597·8	44·9
6½	647·1	52·7
7	696·3	61·1
7½	745·5	70·1
8	794·6	79·7

45 CHAINS RADIUS.

	° ′
Tangential angle for 1 chain	0–38·2
Angle at centre " "	1–16·4
Sine of angle at centre "	·02223
Versine " " "	·00025

Chains	Tangents	Offsets
	Links	Links
½	49·9	0·3
1	99·9	1·1
1½	149·9	2·4
2	199·9	4·4
2½	249·8	6·9
3	299·8	9·9
3½	349·7	13·6
4	399·5	17·7
4½	449·3	22·5
5	499·0	27·7
5½	548·6	33·5
6	598·2	39·9
6½	647·6	46·8
7	697·1	54·3
7½	746·4	62·3
8	795·7	70·8

TABLE V. FOR SETTING OUT CURVES BY OFFSETS AND WITHOUT THEODOLITE FOR THE 66 FEET OR 100 FEET CHAIN.

<table>
<tr><td colspan="3">50 CHAINS RADIUS. ° ′
Tangential angle for 1 chain . . . . 0—34·4
Angle at centre " " . . . . 1—8·7
Sine of angle at centre " . . . . ·01998
Versine " " " . . . . ·00020</td><td colspan="3">55 CHAINS RADIUS. ° ′
Tangential angle for 1 chain . . . . 0—31·2
Angle at centre " " . . . . 1—2·5
Sine of angle at centre " . . . . ·01817
Versine " " " . . . . ·00016</td></tr>
<tr><td>Chains</td><td>Tangents</td><td>Offsets</td><td>Chains</td><td>Tangents</td><td>Offsets</td></tr>
<tr><td></td><td>Links</td><td>Links</td><td></td><td>Links</td><td>Links</td></tr>
<tr><td>½</td><td>49·9</td><td>0·2</td><td>½</td><td>49·9</td><td>0·2</td></tr>
<tr><td>1</td><td>99·9</td><td>1·0</td><td>1</td><td>99·9</td><td>0·9</td></tr>
<tr><td>1½</td><td>149·9</td><td>2·2</td><td>1½</td><td>149·9</td><td>2·0</td></tr>
<tr><td>2</td><td>199·9</td><td>3·9</td><td>2</td><td>199·9</td><td>3·6</td></tr>
<tr><td>2½</td><td>249·8</td><td>6·2</td><td>2½</td><td>249·9</td><td>5·6</td></tr>
<tr><td>3</td><td>299·8</td><td>9·4</td><td>3</td><td>299·8</td><td>8·2</td></tr>
<tr><td>3½</td><td>349·6</td><td>12·2</td><td>3½</td><td>349·7</td><td>11·2</td></tr>
<tr><td>4</td><td>399·5</td><td>16·0</td><td>4</td><td>399·6</td><td>14·5</td></tr>
<tr><td>4½</td><td>449·4</td><td>20·2</td><td>4½</td><td>449·6</td><td>18·4</td></tr>
<tr><td>5</td><td>499·2</td><td>25·0</td><td>5</td><td>499·3</td><td>22·7</td></tr>
<tr><td>5½</td><td>548·8</td><td>30·2</td><td>5½</td><td>549·1</td><td>27·5</td></tr>
<tr><td>6</td><td>598·5</td><td>35·9</td><td>6</td><td>598·8</td><td>32·7</td></tr>
<tr><td>6½</td><td>648·1</td><td>42·2</td><td>6½</td><td>648·6</td><td>38·4</td></tr>
<tr><td>7</td><td>697·7</td><td>48·9</td><td>7</td><td>698·0</td><td>45·0</td></tr>
<tr><td>7½</td><td>747·2</td><td>56·1</td><td>7½</td><td>747·6</td><td>51·0</td></tr>
<tr><td>8</td><td>796·5</td><td>63·8</td><td>8</td><td>797·1</td><td>58·1</td></tr>
</table>

TABLE V. FOR SETTING OUT CURVES BY OFFSETS AND WITHOUT THEODOLITE FOR THE 66 FEET OR 100 FEET CHAIN.

60 CHAINS RADIUS.

	° ′
Tangential angle for 1 chain	0—28·6
Angle at centre " "	0—57·3
Sine of angle at centre "	·01667
Versine " " "	·00014

Chains	Tangents	Offsets
	Links	Links
½	49·9	0·2
1	99·9	0·8
1½	149·9	1·8
2	199·9	3·3
2½	249·9	5·2
3	299·8	7·5
3½	349·7	10·2
4	399·7	13·3
4½	449·5	16·9
5	499·4	20·8
5½	549·2	25·2
6	599·0	30·0
6½	648·7	35·1
7	698·4	40·8
7½	748·0	46·8
8	797·7	53·3

65 CHAINS RADIUS.

	° ′
Tangential angle for 1 chain . , . .	0—26·4
Angle at centre " "	0—52·9
Sine of angle at centre "	·01539
Versine " " "	·00012

Chains	Tangents	Offsets
	Links	Links
½	49·9	0·2
1	99·9	0·8
1½	149·9	1·7
2	199·9	3·1
2½	249·9	4·8
3	299·8	6·9
3½	349·8	9·4
4	399·8	12·3
4½	449·7	15·6
5	499·4	19·2
5½	549·6	23·3
6	599·2	27·7
6½	648·9	32·5
7	698·6	37·6
7½	748·4	43·2
8	797·9	49·1

TABLE V. FOR SETTING OUT CURVES BY OFFSETS AND WITHOUT THEODOLITE FOR THE 66 FEFT OR 100 FEET CHAIN.

70 CHAINS RADIUS.

	° ′
Tangential angle for 1 chain	0 – 24·5
Angle at centre " "	0 – 49·0
Sine of angle at centre "	·01425
Versine " " "	·00010

Chains	Tangents	Offsets
	Links	Links
½	49·9	0·3
1	99·9	0·7
1½	149·9	1·6
2	199·9	2·9
2½	249·9	4·5
3	299·8	6·4
3½	349·9	8·8
4	399·7	11·4
4½	449·7	14·5
5	499·8	17·8
5½	549·4	21·6
6	599·1	25·7
6½	648·9	30·1
7	698·9	35·0
7½	748·5	40·1
8	798·3	45·7

80 CHAINS RADIUS.

	° ′
Tangential angle for 1 chain	0 – 21·5
Angle at centre " "	0 – 43·0
Sine of angle at centre "	·01251
Versine " " "	·00008

Chains	Tangents	Offsets
	Links	Links
½	49·9	0·2
1	99·9	0·6
1½	149·9	1·4
2	199·9	2·5
2½	249·9	3·9
3	299·8	5·6
3½	349·9	7·7
4	399·8	10·0
4½	449·9	12·6
5	499·8	15·7
5½	549·4	18·9
6	599·4	22·6
6½	649·3	26·4
7	699·0	30·6
7½	748·8	35·1
8	798·7	40·0

CONTRACT EARTHWORK TABLES AND MEASURING UP.

The accompanying Earthwork Tables have been prepared with a view of sparing labour and economising time in computations not only of great length, but always of considerable importance in railway, road, and other contracts, always requiring a great amount of checking before the calculations are considered as satisfactory. Having been worked out for every six inches in depth, they will be found to produce more accurate, and, in contract matters, more satisfactory results, than are usually obtained. During the last eighteen months the writer has had to take out contract quantities of earthwork on some long and heavy lines, and the contractors particularly requested that the calculations should be made on this system. The tables in ordinary use only give quantities for every foot in depth; those now submitted give the quantities for every *six inches in depth*: and when it is considered that in cuttings, say from 30 to 35 feet deep, for every six inches in depth the quantities for the slopes only are upwards of 180 cubic yards, and for earthworks at 2 to 1, and for the same depths, the differences are 250 cubic yards, it is not surprising that there has almost always been so much dissatisfaction in contract matters about earthwork calculations.

To make this plainer, and at the same time explain the use of the tables, let the following few depths of cutting, from portion of a contract section, serve as an example. It is not that the *most perfect* accuracy of the tables in ordinary use is questioned; but they are not carried far enough, nor sufficiently detailed.

Formation, 20 feet; slopes 1½ to 1; 100 feet chain.

I.	II.	III.	IV.
31·90 32·40	8059·3	8059·3	32·05
34·50	8496	8716·2	33·45
38·20	10109	10105·1	36·35
42·43	11859	12112·5	40·31
46·68	14309	14297·7	44·65
52·30	17281	17279·2	49·49
49·42	17904	18227·8	50·82
49·30	16968	17279·2	49·56
		106077·0	

In the above, Column I. gives the depths of the cutting in feet and decimals, and Column II., the quantities in cubic yards, from the tables in ordinary use. Column III gives the quantities in cubic yards, taken from the accompanying tables, and due to the *mean* heights given in Column IV. Thus, 31·90 and 32·40 in Column I. give 32·05 for a mean depth in Column IV., and the tabular number in Table VI., for a formation width of 20 feet, with 32 feet depth, gives 2370·4 cubic yards; for the slope of 1½ to 1, Table VII. gives 5688·9 cubic yards, at the same depth of 32 feet, and these two numbers, added together, 8059·3 cubic yards, entered in Column III.

It will be observed of these tables, that the writer has adopted the plan of separating the quantities due to the formation width from those due to the slopes; this has enabled him to bring within a very small compass tables calculated for every six inches in depth up to 80 feet, for 10 different widths at formation, and for 8 different slopes; there is no other trouble in making use of them, than to pick out the tabular numbers and add them up, and the circumstance of their being calculated to half a foot, makes them, in actual *contract* practice, much more accurate than tables calculated by the prismoidal formula for only every foot in depth, it being, of course, understood that in making use of these tables, it is to be done chain by chain of 100 feet along the length of section.

It is also to be observed that the plan adopted of separating the formation quantities from the slope quantities, offers great facilities in adjusting the balance of earthworks; that is, of widening embankments for the disposal of excess of cutting, or *vice versâ*: and also where it is advisable to resort to side cutting in the formation of embankments in preference to extra cutting from the excavations, all allowance being made for the long haulage of empty waggons over steep gradients, which are now the rule instead of the exception.

Every engineer knows the importance of cross sections in order to arrive at practically and satisfactorily accurate results in determining the quantities in heavy earthworks; he knows also that to obtain these results great care is required in plotting the cross sections of cuttings and embankments. Though the operation is exceedingly simple, he is equally well aware of the amount of time occupied in calculating the areas, and in checking the work. The Earthwork Tables here given will materially assist in reducing the time and care required in these operations to a minimum. In the annexed figure, is a cutting in sidelying ground 35 feet deep at centre stump, but at A the depth scales only 30·75; set off B A equal to 30·50, and the tables at once give the quantity in cubic yards due to the area A B′ C D, leaving merely the area of the triangle A D E to calculate. If the area A B′ C D is calculated from the cross section, the quantities from the tables will prove if A B′, B C, and C D have been correctly plotted, and the area accurately calculated; the work will be safe from all chance of error.

In heavy earthworks, we are all aware that in preparing the quantities for the monthly certificates, the work of squaring up from measurements taken on the ground always occupies considerable time. Table I. of Earthworks will be found to save much time in making these calculations, or in checking them, as the annexed figures will show. In fig. A, let *a* be 12 feet wide and 15 feet high, then, by Table VI., we have 666·7 cubic yards due to this area; let *b* be 30 feet mean width, and 10 feet mean height; twice 15 = 30; on the 10 feet in column 30 we have 555·6 cubic yards, and this, multiplied by 2, gives 1111·2 cubic yards for the portion *b*; let the portion *c* be 65 feet mean width, and 9 feet mean height; we may take twice 24 plus 17 = 67 by 8, and we shall have—

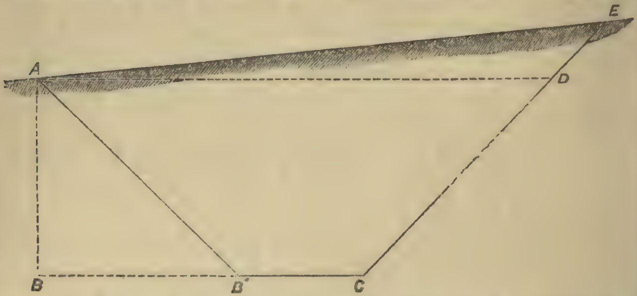
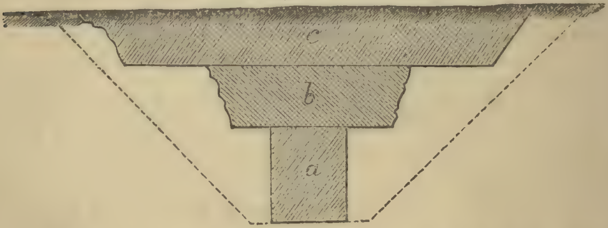


Fig. A.



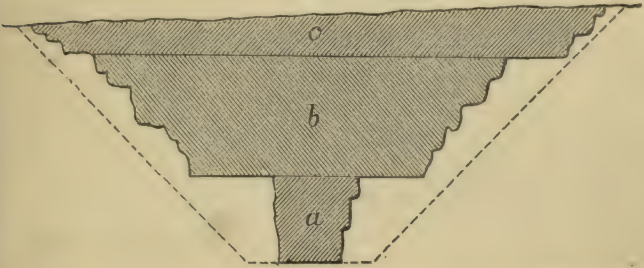
$$\begin{array}{r} 711{\cdot}1 \\ 711{\cdot}1 \\ 503{\cdot}7 \\ \hline 1925{\cdot}9 \end{array}$$

And for the whole area of A we shall have—

$$\begin{array}{r} \text{Cubic yards.} \\ a = 666{\cdot}7 \\ b = 1111{\cdot}2 \\ c = 1925{\cdot}9 \\ \hline 3703{\cdot}8 = \text{A}. \end{array}$$

At the next point of measurement determined on, let the cross section be as in fig B. Let *a* be 12 feet wide and 16½ feet high; for this first portion we get from Table VI., opposite 16·5, 733·0 cubic yards; for *b* let the mean width agreed to be 50 feet, and depth 20; then 24 plus 26 being equal to 50, we take out from opposite 20 feet deep 1777·8 cubic yards, and 1925·9 cubic yards = 3703·7 cubic yards; for portion *c* let the mean width and mean height be 98 feet and 10 feet; then for width we shall have four times 20 and 18 = 98, which will give from the tables 2962·8 and 666·7, equal to 3629·5 cubic yards. For the whole due to area B, we shall have—

Fig. B.



$$\begin{aligned} a &= 733{\cdot}3 \\ b &= 3703{\cdot}7 \\ c &= 3629{\cdot}5 \\ \hline & 8066{\cdot}5 \text{ cubic yards} = B. \end{aligned}$$

The mean of 3703·8 and 8066·5 is equal to 5885 cubic yards, being the quantity upon a length of 100 feet. But let us suppose that it is 190 feet instead of 100; then we take the 90 as a decimal, and we shall have—

$$\begin{array}{r} 5885 \\ 1{\cdot}9 \\ \hline 5296{\cdot}5 \\ 5885 \\ \hline 11181{\cdot}5 \text{ cubic yards.} \end{array}$$

We will conclude by an apology to engineers for the details above given; but they will be so good as to remember that these pages will come into the hands of students, and even of working men, and that, necessarily, explanations must be full and simple.

TABLE VI. FOR CENTRAL OR FORMATION WIDTHS.

QUANTITIES IN CUBIC YARDS PER 100 FEET CHAIN.

Depths in feet.	FORMATION WIDTHS.									
	12 feet.	15 feet.	16 feet.	17 feet.	18 feet.	20 feet.	22 feet.	24 feet.	26 feet.	28 feet.
1·0	44·4	55·6	59·3	63·0	66·7	74·1	81·5	88·9	96·3	103·1
1·5	66·7	83·3	88·9	94·4	100·0	111·1	122·2	133·3	144·4	155·6
2·0	88·9	111·1	118·5	125·9	133·3	148·1	163·0	177·8	192·6	207·4
2·5	111·1	138·9	148·1	157·4	166·7	185·2	203·7	222·2	240·7	259·3
3·0	133·3	166·7	177·8	188·9	200·0	222·2	244·4	266·7	288·9	311·1
3·5	155·5	194·4	207·4	220·4	233·3	259·3	285·2	311·1	337·0	363·0
4·0	177·8	222·2	237·0	251·9	266·7	296·3	325·9	355·6	385·2	414·8
4·5	200·0	250·0	266·7	283·3	300·0	333·3	366·7	400·0	433·3	466·7
5·0	222·2	277·8	296·3	314·8	333·3	370·4	407·4	444·4	481·5	518·5
5·5	244·4	305·6	325·9	346·3	366·7	407·4	448·1	488·9	529·6	570·4
6·0	266·7	333·3	355·6	377·8	400·0	444·4	488·9	533·3	577·8	622·2
6·5	288·9	361·1	385·2	409·3	433·3	481·5	529·6	577·8	625·9	674·1
7·0	311·1	388·9	414·8	440·7	466·7	518·5	570·4	622·2	674·1	725·9
7·5	333·3	416·7	444·4	472·2	500·0	555·5	611·1	666·7	722·2	777·8
8·0	355·6	444·4	474·1	503·7	533·3	592·6	651·9	711·1	770·4	829·6
8·5	377·8	472·2	503·7	535·2	566·7	629·6	692·6	755·6	818·5	881·5
9·0	400·0	500·0	533·3	566·7	600·0	666·7	733·3	800·0	866·7	933·3
9·5	422·2	527·8	563·0	598·1	633·3	703·7	774·1	844·4	914·8	985·2
10·0	444·4	555·6	592·6	629·6	666·7	740·7	814·8	888·9	963·0	1037·0
10·5	466·7	583·3	622·2	661·1	700·0	777·8	855·6	933·3	1011·1	1088·9
11·0	488·9	611·1	651·9	692·6	733·3	814·8	896·3	977·8	1059·3	1140·7
11·5	511·1	638·9	681·5	724·1	766·7	851·9	937·0	1022·2	1107·4	1192·6
12·0	533·3	666·7	711·1	755·6	800·0	888·9	977·8	1066·7	1155·6	1244·4

13·0	577·8	722·2	770·4	818·5	866·7	963·0	1059·3	1155·6	1251·9	1348·1
13·5	600·0	750·0	800·0	850·0	900·0	1000·0	1100·0	1200·0	1300·0	1400·0
14·0	622·2	777·8	829·6	881·5	933·3	1037·0	1140·7	1244·4	1348·1	1451·9
14·5	644·4	805·6	859·3	913·0	966·7	1074·1	1181·5	1288·9	1396·3	1503·7
15·0	666·7	833·3	888·9	944·4	1000·0	1111·1	1222·2	1333·3	1444·4	1555·6
15·5	688·9	861·1	918·5	975·9	1033·3	1148·1	1263·0	1377·8	1492·6	1607·4
16·0	711·1	888·9	948·1	1007·4	1066·6	1185·2	1303·7	1422·2	1540·7	1659·3
16·5	733·3	916·7	977·8	1038·9	1100·0	1222·2	1344·4	1466·7	1588·9	1711·1
17·0	755·6	944·4	1007·4	1070·4	1133·3	1259·3	1385·2	1511·1	1637·0	1763·0
17·5	777·8	972·2	1037·0	1101·9	1166·7	1296·3	1425·9	1555·6	1685·2	1814·8
18·0	800·0	1000·0	1066·7	1133·3	1200·0	1333·3	1466·7	1600·0	1733·3	1866·7
18·5	822·2	1027·7	1096·3	1164·8	1233·3	1370·4	1507·4	1644·4	1781·5	1918·5
19·0	844·4	1055·5	1125·9	1196·3	1266·7	1407·4	1548·1	1688·9	1829·6	1970·4
19·5	866·7	1083·3	1155·6	1227·8	1300·0	1444·4	1588·9	1733·3	1877·8	2022·2
20·0	888·9	1111·1	1185·2	1259·3	1333·3	1481·5	1629·6	1777·8	1925·9	2074·1
20·5	911·1	1138·9	1214·8	1290·7	1366·7	1518·5	1670·4	1822·2	1974·1	2125·9
21·0	933·3	1166·7	1244·4	1322·2	1400·0	1555·5	1711·1	1866·7	2022·2	2177·8
21·5	955·6	1194·4	1274·1	1353·7	1433·3	1592·6	1751·9	1911·1	2070·4	2229·6
22·0	977·8	1222·2	1303·7	1385·2	1466·7	1629·6	1792·6	1955·6	2118·5	2281·5
22·5	1000·0	1250·0	1333·3	1416·7	1500·0	1666·7	1833·3	2000·0	2166·7	2333·3
23·0	1022·2	1277·7	1363·0	1448·1	1533·3	1703·7	1874·1	2044·4	2214·8	2385·2
23·5	1044·4	1305·5	1392·6	1479·6	1566·7	1740·7	1914·8	2088·9	2263·0	2437·0
24·0	1066·7	1333·3	1422·2	1511·1	1600·0	1777·8	1955·6	2133·3	2311·1	2488·9
24·5	1088·9	1361·1	1451·9	1542·6	1633·3	1814·8	1996·3	2177·8	2359·3	2540·7
25·0	1111·1	1388·9	1481·5	1574·1	1666·7	1851·9	2037·0	2222·2	2407·4	2592·6
25·5	1133·3	1416·7	1511·1	1605·6	1700·0	1888·9	2077·8	2266·7	2455·6	2644·4
26·0	1155·6	1444·4	1540·7	1637·0	1733·3	1925·9	2118·5	2311·1	2503·7	2696·3
26·5	1177·8	1472·2	1570·4	1668·5	1766·7	1963·0	2159·3	2355·6	2551·9	2748·1
27·0	1200·0	1500·0	1600·0	1700·0	1800·0	2000·0	2200·0	2400·0	2600·0	28·000
27·5	1222·2	1527·8	1629·6	1731·5	1833·3	2037·0	2240·7	2444·4	2648·1	2851·9

TABLE VI.—*continued.*

Depths, in feet.	FORMATION WIDTHS.									
	12 feet.	15 feet.	16 feet.	17 feet.	18 feet.	20 feet.	22 feet.	24 feet.	26 feet.	28 feet.
28·0	1244·4	1555·6	1659·3	1763·0	1866·6	2074·1	2281·5	2488·9	2696·3	2903·7
28·5	1266·7	1583·3	1688·9	1794·4	1900·0	2111·1	2322·2	2533·3	2744·4	2955·6
29·0	1288·9	1611·1	1718·5	1825·9	1933·3	2148·1	2363·0	2577·8	2792·6	3007·4
29·5	1311·1	1638·9	1748·1	1857·4	1966·7	2185·2	2403·7	2622·2	2840·7	3059·3
30·0	1333·3	1666·7	1777·8	1888·9	2000·0	2222·2	2444·4	2666·7	2888·9	3111·1
30·5	1355·6	1694·4	1807·4	1920·4	2033·3	2259·3	2485·2	2711·1	2937·0	3163·0
31·0	1377·8	1722·2	1837·0	1951·9	2066·7	2296·3	2525·9	2755·6	2985·2	3214·8
31·5	1400·0	1750·0	1866·7	1983·3	2100·0	2333·3	2566·7	2800·0	3033·3	3266·7
32·0	1422·2	1777·8	1896·3	2014·8	2133·3	2370·4	2607·4	2844·4	3081·5	3318·5
32·5	1444·4	1805·6	1925·9	2046·3	2166·7	2407·4	2648·1	2888·9	3129·6	3370·4
33·0	1466·7	1833·3	1955·6	2077·8	2200·0	2444·4	2688·9	2933·3	3177·8	3422·2
33·5	1488·9	1861·1	1985·2	2109·3	2233·3	2481·5	2729·6	2977·8	3225·9	3474·1
34·0	1511·1	1888·9	2014·8	2140·7	2266·7	2518·5	2770·4	3022·2	3274·1	3525·9
34·5	1533·3	1916·7	2044·4	2172·2	2300·0	2555·6	2811·1	3066·7	3322·2	3577·8
35·0	1555·5	1944·4	2074·1	2203·7	2333·3	2592·6	2851·9	3111·1	3370·4	3629·6
35·5	1577·8	1972·2	2103·7	2235·2	2366·7	2629·6	2892·6	3155·5	3418·5	3681·5
36·0	1600·0	2000·0	2133·3	2266·7	2400·0	2666·7	2933·3	3200·0	3466·7	3733·3
36·5	1622·2	2027·8	2163·0	2298·1	2433·3	2703·7	2974·1	3244·4	3514·8	3785·2
37·0	1644·4	2055·6	2192·6	2329·6	2466·7	2740·7	3014·8	3288·9	3563·0	3837·0
37·5	1666·6	2083·3	2222·2	2361·1	2500·0	2777·8	3055·6	3333·3	3611·1	3888·9
38·0	1688·9	2111·1	2251·9	2392·6	2533·3	2814·8	3096·3	3377·8	3659·3	3940·7
38·5	1711·1	2138·9	2281·5	2424·1	2566·7	2851·9	3137·0	3422·2	3707·4	3992·6
39·0	1733·3	2166·7	2311·1	2455·6	2600·0	2888·9	3177·8	3466·7	3755·6	4044·4
39·5	1755·6	2194·4	2340·7	2487·0	2633·3	2925·9	3218·5	3511·1	3803·7	4096·3

40·0	1777·8	2222·2	2370·4	2518·5	2666·7	2963·0	3259·3	3555·6	3851·9	4148·1
40·5	1800·0	2250·0	2400·0	2550·0	2700·0	3000·0	3300·0	3600·0	3900·0	4200·0
41·0	1822·2	2277·8	2429·6	2581·5	2733·3	3037·0	3340·7	3644·4	3948·1	4251·9
41·5	1844·4	2305·6	2459·3	2613·0	2766·7	3074·1	3381·5	3688·9	3996·3	4303·7
42·0	1866·7	2333·3	2488·9	2644·0	2800·0	3111·1	3422·2	3733·3	4044·4	4355·6
42·5	1888·9	2361·1	2518·5	2675·9	2833·3	3148·1	3463·0	3777·8	4092·6	4407·4
43·0	1911·1	2388·9	2548·1	2707·4	2866·7	3185·2	3503·7	3822·2	4140·7	4459·3
43·5	1933·3	2416·7	2577·8	2738·9	2900·0	3222·2	3544·4	3866·7	4188·9	4511·1
44·0	1955·5	2444·4	2607·4	2770·4	2933·3	3259·3	3585·2	3911·1	4237·0	4563·0
44·5	1977·8	2472·2	2637·0	2801·9	2966·7	3296·3	3625·9	3955·6	4285·2	4614·8
45·0	2000·0	2500·0	2666·7	2833·3	3000·0	3333·3	3666·7	4000·0	4333·3	4666·7
45·5	2022·2	2527·8	2696·3	2864·8	3033·3	3370·4	3707·4	4044·4	4381·5	4718·5
46·0	2044·4	2555·6	2725·9	2896·3	3066·7	3407·4	3748·1	4088·9	4429·6	4770·4
46·5	2066·7	2583·3	2755·6	2927·8	3100·0	3444·4	3788·9	4133·3	4477·8	4822·2
47·0	2088·9	2611·1	2785·2	2959·3	3133·3	3481·5	3829·6	4177·8	4525·9	4874·1
47·5	2111·1	2638·9	2814·8	2990·7	3166·7	3518·5	3870·4	4222·2	4574·1	4925·9
48·0	2133·3	2666·7	2844·4	3022·2	3200·0	3555·6	3911·1	4266·7	4622·2	4977·8
48·5	2155·6	2694·4	2874·1	3053·7	3233·3	3592·6	3951·9	4311·1	4670·4	5029·6
49·0	2177·8	2722·2	2903·7	3085·2	3266·7	3629·6	3992·6	4355·6	4718·5	5081·5
49·5	2200·0	2750·0	2933·3	3116·7	3300·0	3666·7	4033·3	4400·0	4766·7	5133·3
50·0	2222·2	2777·8	2963·0	3148·1	3333·3	3703·7	4074·1	4444·0	4814·8	5185·2
50·5	2244·4	2805·6	2992·6	3179·6	3366·7	3740·7	4114·8	4488·9	4863·0	5237·0
51·0	2266·7	2833·3	3022·2	3211·1	3400·0	3777·8	4155·6	4533·3	4911·1	5288·9
51·5	2288·9	2861·1	3051·9	3242·6	3433·3	3814·8	4196·3	4577·8	4959·3	5340·7
52·0	2311·1	2888·9	3081·5	3274·1	3466·7	3851·9	4237·0	4622·2	5007·4	5392·6
52·5	2333·3	2916·7	3111·1	3305·6	3500·0	3888·9	4277·8	4666·7	5055·6	5444·4
53·0	2355·6	2944·4	3140·7	3337·0	3533·3	3925·9	4318·5	4711·1	5103·7	5496·3
53·5	2377·8	2972·2	3170·4	3368·5	3566·7	3963·0	4359·3	4755·6	5151·9	5548·1
54·0	2400·0	3000·0	3200·0	3400·0	3600·0	4000·0	4400·0	4800·0	5200·0	5600·0
54·5	2422·2	3027·8	3229·6	3431·5	3633·3	4037·0	4440·7	4844·4	5248·1	5651·9

TABLE VI.—*continued.*

Depths, in feet.	FORMATION WIDTHS.									
	12 feet.	15 feet.	16 feet.	17 feet.	18 feet.	20 feet.	22 feet.	24 feet.	26 feet.	28 feet.
55·0	2444·4	3055·6	3259·3	3463·0	3666·7	4074·1	4481·5	4888·9	5296·3	5703·7
55·5	2466·7	3083·3	3288·9	3494·4	3700·0	4111·1	4522·2	4933·3	5344·4	5755·6
56·0	2488·9	3111·1	3318·5	3525·9	3733·3	4148·1	4563·0	4977·8	6392·6	5807·4
56·5	2511·1	3138·9	3348·1	3557·4	3766·7	4185·2	4603·7	5022·2	5440·7	5859·3
57·0	2533·3	3166·7	3377·8	3588·9	3800·0	4222·2	4644·4	5066·7	5488·9	5911·1
57·5	2555·6	3194·4	3407·4	3620·4	3833·3	4259·3	4685·2	5111·1	5537·0	5963·0
58·0	2577·7	3222·2	3437·0	3651·9	3866·6	4296·3	4725·9	5155·6	5585·2	6014·8
58·5	2600·0	3250·0	3466·7	3683·3	3900·0	4333·3	4766·7	5200·0	5633·3	6066·7
59·0	2622·2	3277·8	3496·3	3714·8	3933·3	4370·4	4807·4	5244·4	5681·5	6118·5
59·5	2644·4	3305·6	3525·9	3746·3	3966·7	4407·4	4848·1	5288·9	5729·6	6170·4
60·0	2666·7	3333·3	3555·6	3777·8	4000·0	4444·4	4888·9	5333·3	5777·8	6222·2
60·5	2688·9	3361·1	3585·2	3809·3	4033·3	4481·5	4929·6	5377·8	5825·9	6274·1
61·0	2711·1	3388·9	3614·8	3840·7	4066·7	4518·5	4970·4	5422·2	5874·1	6325·9
61·5	2733·3	3416·7	3644·4	3872·2	4100·0	4555·6	5011·1	5466·7	5922·2	6377·8
62·0	2755·6	3444·4	3674·1	3903·7	4133·3	4592·6	5051·9	5511·1	5970·4	6429·6
62·5	2777·8	3472·2	3703·7	3935·2	4166·7	4629·6	5092·6	5555·6	6018·5	6481·5
63·0	2800·0	3500·0	3733·3	3966·7	4200·0	4666·7	5133·3	5600·0	6066·7	6533·3
63·5	2822·2	3527·8	3763·0	3998·1	4233·3	4703·7	5174·1	5644·4	6114·8	6585·2
64·0	2844·4	3555·6	3792·6	4029·6	4266·7	4740·7	5214·8	5688·9	6163·0	6637·0
64·5	2866·7	3583·3	3822·2	4061·1	4300·0	4777·8	5255·6	5733·3	6211·1	6688·9
65·0	2888·9	3611·1	3851·8	4092·6	4333·3	4814·8	5296·3	5777·8	6259·3	6740·7
65·5	2911·1	3638·9	3881·5	4124·1	4366·7	4851·9	5337·0	5822·2	6307·4	6792·6
66·0	2933·3	3666·7	3911·1	4155·6	4400·0	4888·9	5377·8	5866·7	6355·6	6844·4
66·5	2955·6	3694·4	3940·7	4187·0	4433·3	4925·9	5418·5	5911·1	6403·7	6896·3

67·0	2977·8	3722·2	3970·4	4218·5	4466·7	4963·0	5459·3	5955·6	6451·9	6948·1
67·5	3000·0	3750·0	4000·0	4250·0	4500·0	5000·0	5500·0	6000·0	6500·0	7000·0
68·0	3022·2	3777·8	4029·6	4281·5	4533·3	5037·0	5540·7	6044·4	6548·1	7051·9
68·5	3044·4	3805·6	4059·2	4313·0	4566·7	5074·1	5581·5	6088·9	6596·3	7103·7
69·0	3066·7	3833·3	4088·9	4344·4	4600·0	5111·1	5622·2	6133·3	6644·4	7155·6
69·5	3088·9	3861·1	4118·5	4375·9	4633·3	5148·2	5663·0	6177·8	6692·6	7207·4
70·0	3111·1	3888·9	4148·1	4407·4	4666·7	5185·2	5703·7	6222·2	6740·7	7259·3
70·5	3133·3	3916·7	4177·8	4438·9	4700·0	5222·2	5744·4	6266·7	6788·9	7311·1
71·0	3155·5	3944·4	4207·4	4470·4	4733·3	5259·3	5785·2	6311·1	6837·0	7363·0
71·5	3177·8	3972·2	4237·0	4501·9	4766·7	5296·3	5825·9	6355·6	6885·2	7414·8
72·0	3200·0	4000·0	4266·7	4533·3	4800·0	5333·3	5866·7	6400·0	6933·3	7466·7
72·5	3222·2	4027·8	4296·3	4564·8	4833·3	5370·4	5907·4	6444·4	6981·5	7518·5
73·0	3244·4	4055·6	4325·9	4596·3	4866·7	5407·4	5948·2	6488·9	7029·6	7570·4
73·5	3266·7	4083·3	4355·6	4627·8	4900·0	5444·4	5988·9	6533·3	7077·8	7622·2
74·0	3288·9	4111·1	4385·2	4659·3	4933·3	5481·5	6029·6	6577·8	7125·9	7674·1
74·5	3311·1	4138·9	4414·8	4690·7	4966·7	5518·5	6070·4	6622·2	7174·1	7725·9
75·0	3333·3	4166·7	4444·4	4722·2	5000·0	5555·6	6111·1	6666·7	7222·2	7777·8
75·5	3355·6	4194·4	4474·1	4753·7	5033·3	5592·6	6151·9	6711·1	7270·4	7829·6
76·0	3377·7	4222·2	4503·7	4785·2	5066·7	5629·6	6192·6	6755·6	7318·5	7881·5
76·5	3400·0	4250·0	4533·3	4816·7	5100·0	5666·7	6233·3	6800·0	7366·7	7933·3
77·0	3422·2	4277·8	4563·0	4848·1	5133·3	5703·7	6274·1	6844·4	7414·8	7985·2
77·5	3444·4	4305·6	4592·6	4879·6	5166·7	5740·7	6314·8	6888·9	7463·0	8037·0
78·0	3466·7	4333·3	4622·2	4911·1	5200·0	5777·8	6355·6	6933·3	7511·1	8088·9
78·5	3488·9	4361·1	4651·9	4942·6	5233·3	5814·8	6396·3	6977·8	7559·3	8140·7
79·0	3511·1	4388·9	4681·5	4974·1	5266·7	5851·9	6437·0	7022·2	7607·4	8192·6
79·5	3533·3	4416·7	4711·1	5005·6	5300·0	5888·9	6477·8	7066·7	7655·6	8244·4
80·0	3555·6	4444·4	4740·7	5037·0	5333·3	5925·9	6518·5	7111·1	7703·7	8296·3

TABLE VII. FOR SLOPES.

QUANTITIES IN CUBIC YARDS PER 100 FEET CHAIN.

Depths in feet.	RATIO OF SLOPES.						
	¼ to 1.	½ to 1.	¾ to 1.	1 to 1.	1¼ to 1.	1½ to 1.	2 to 1.
1·0	0·9	1·9	2·8	3·7	4·6	5·6	7·4
1·5	2·1	4·2	6·2	8·3	10·4	12·5	16·7
2·0	3·7	7·4	11·1	14·8	18·5	22·2	29·6
2·5	5·8	11·6	17·4	23·2	28·9	34·7	46·3
3·0	8·3	16·7	25·0	33·3	41·7	50·0	66·7
3·5	11·3	22·7	34·0	45·4	56·7	68·1	90·7
4·0	14·8	29·6	44·4	59·3	74·1	88·9	118·5
4·5	18·8	37·5	56·3	75·0	93·7	112·5	150·0
5·0	23·1	46·3	69·4	92·6	115·7	138·9	185·2
5·5	28·00	56·0	84·0	112·0	140·0	168·1	224·1
6·0	33·3	66·7	100·0	133·3	166·6	200·0	266·7
6·5	39·1	78·2	117·4	156·5	195·6	234·7	313·0
7·0	45·4	90·7	136·1	181·5	226·9	272·2	363·0
7·5	52·1	104·2	156·2	208·3	260·4	312·5	416·7
8·0	59·3	118·5	177·8	237 0	296·3	335·6	474·1
8·5	66·9	133·8	200·7	267·6	334·5	401·4	535·2
9·0	75·00	150·0	225·0	300·0	375·0	450·0	600·0
9·5	83·6	167·1	250·7	334·3	417·8	501·4	668·5
10·0	92·6	185·2	277·8	370·4	463·0	555·6	740·7
10·5	102·1	204·2	306·2	408·3	510·4	612·5	816·7
11·0	112·0	224·1	336·1	448·2	560·2	672·2	896·3
11·5	122·5	244·9	367·4	489·8	612·3	734·7	979·6
12·0	133·3	266·7	400·0	533·3	666·7	800·0	1066·7

13·0	156·5	313·0	469·4	626·0	782·4	938·9	1251·9
13·5	168·8	337·5	506·3	675·0	843·8	1012·5	1350·0
14·0	181·5	363·0	544·4	725·9	907·4	1088·9	1451·9
14·5	194·7	389·4	584·0	778·7	973·4	1168·1	1557·4
15·0	208·3	416·7	625·0	833·3	1041·7	1250·0	1666·7
15·5	222·5	444·9	667·4	889·8	1112·3	1334·7	1779·6
16·0	237·0	474·1	711·1	948·2	1185·2	1422·2	1896·3
16·5	252·1	504·2	756·2	1008·3	1260·4	1512·5	2016·7
17·0	267·6	535·2	802·8	1070·4	1338·0	1605·6	2140·7
17·5	283·6	567·1	850·7	1134·3	1417·8	1701·4	2268·5
18·0	300·00	600·0	900·0	1200·0	1500·0	1800·0	2400·0
18·5	316·9	633·8	950·7	1267·6	1584·5	1901·4	2535·2
19·0	334·3	668·5	1002·8	1337·0	1671·3	2005·6	2674·1
19·5	352·1	704·2	1056·2	1408·3	1760·4	2112·5	2816·7
20·0	370·4	740·7	1111·1	1481·5	1851·9	2222·2	2963·0
20·5	389·1	778·2	1167·4	1556·5	1945·6	2334·7	3113·0
21·0	408·3	816·7	1225·0	1633·3	2041·7	2450·0	3266·7
21·5	428·0	856·0	1284·0	1712·0	2140·1	2568·1	3424·1
22·0	448·1	896·3	1344·4	1792·6	2240·7	2688·9	3585·2
22·5	468·7	937·5	1406·2	1875·0	2343·7	2812·5	3750·0
23·0	489·8	979·6	1469·4	1959·3	2449·0	2938·9	3918·5
23·5	511·3	1022·7	1534·0	2045·4	2556·7	3068·1	4090·7
24·0	533·3	1066·7	1600·0	2133·3	2666·7	3200·0	4266·7
24·5	555·8	1111·6	1667·4	2223·2	2778·9	3334·7	4446·3
25·0	578·7	1157·4	1736·1	2314·8	2893·5	3472·2	4629·6
25·5	602·1	1204·2	1806·2	2408·3	3010·4	3612·5	4816·7
26·0	625·9	1251·9	1877·8	2503·7	3129·6	3755·6	5007·4
26·5	650·2	1300·5	1950·7	2600·9	3251·2	3901·4	5201·9
27·0	675·0	1350·0	2025·0	2700·0	3375·0	4050·00	5400·0
27·5	700·2	1400·5	2100·7	2800·9	3501·2	4201·4	5601·9

TABLE VII.—*continued.*

Depths in feet.	RATIO OF SLOPES.						
	¼ to 1.	½ to 1.	¾ to 1.	1 to 1.	1¼ to 1.	1½ to 1.	2 to 1.
28·0	725·9	1451·9	2177·8	2903·7	3629·6	4355·6	5807·4
28·5	752·1	1504·2	2256·2	3008·3	3760·4	4512·5	6016·7
29·0	778·7	1557·4	2336·1	3114·8	3893·5	4672·2	6229·6
29·5	805·8	1611·6	2417·4	3223·2	4028·9	4834·7	6446·3
30·0	833·3	1666·7	2500·0	3333·3	4166·7	5000·0	6666·7
30·5	861·3	1722·7	2584·0	3445·4	4306·7	5168·1	6890·7
31·0	889·8	1779·6	2669·4	3559·3	4440·1	5338·9	7118·5
31·5	918·8	1837·5	2756·3	3675·0	4593·8	5512·5	7350·0
32·0	948·1	1896·3	2844·4	3792·6	4740·7	5688·9	7585·2
32·5	978·0	1956·0	2934·0	3912·0	4890·1	5868·1	7824·1
33·0	1008·3	2016·7	3025·0	4033·3	5041·6	6050·0	8066·7
33·5	1039·1	2078·2	3117·4	4156·5	5195·6	6234·7	8313·0
34·0	1070·4	2140·7	3211·1	4281·5	5351·9	6422·2	8563·0
34·5	1102·1	2204·2	3306·2	4408·3	5510·4	6612·5	8817·0
35·0	1134·3	2268·5	3402·8	4537·0	5671·3	6805·6	9074·1
35·5	1166·9	2333·8	3500·7	4667·6	5834·5	7001·4	9335·2
36·0	1200·0	2400·1	3600·0	4800·0	6000·0	7200·0	9600·0
36·5	1233·6	2467·1	3700·7	4934·3	6167·8	7401·4	9868·5
37·0	1267·6	2535·2	3802·8	5070·4	6338·0	7605·6	10140·7
37·5	1302·1	2604·2	3906·2	5208·3	6510·4	7812·5	10416·7
38·0	1337·0	2674·1	4011·1	5348·2	6685·2	8022·2	10696·3
38·5	1372·5	2744·9	4117·4	5489·8	6862·3	8234·7	10979·6
39·0	1408·3	2816·6	4225·0	5633·3	7041·7	8450·0	11266·7
39·5	1444·7	2889·4	4334·0	5778·7	7223·4	8668·1	11557·4

40·0	1481·5	2963·0	4444·4	5925·9	7407·4	8888·9	11851·9
40·5	1518·8	3037·5	4556·3	6075·0	7593·8	9112·5	12150·0
41·0	1556·5	3113·0	4669·4	6225·9	7782·4	9338·9	12452·0
41·5	1594·7	3189·4	4784·0	6378·7	7973·4	9568·1	12757·4
42·0	1633·3	3266·7	4900·0	6533·3	8166·7	9800·0	13066·7
42·5	1672·5	3344·9	5017·4	6689·8	8362·3	10034·7	13379·6
43·0	1712·0	3424·1	5136·1	6848·2	8560·2	10272·2	13696·3
43·5	1752·1	3504·2	5256·2	7008·3	8760·4	10512·5	14016·7
44·0	1792·6	3585·2	5377·8	7170·4	8963·0	10755·6	14340·7
44·5	1833·6	3667·1	5500·7	7334·3	9167·8	11001·4	14668·5
45·0	1875·0	3750·0	5625·0	7500·0	9375·0	11250·0	15000·0
45·5	1916·9	3833·8	5750·7	7667·6	9584·5	11501·4	15335·2
46·0	1959·3	3918·5	5877·8	7837·0	9796·3	11755·6	15674·1
46·5	2002·1	4004·2	6006·2	8008·3	10010·4	12012·5	16016·7
47·0	2045·4	4090·7	6136·1	8181·5	10226·9	12272·2	16363·0
47·5	2089·1	4178·3	6267·4	8356·5	10445·6	12534·7	16713·0
48·0	2133·3	4266·7	6400·0	8533·3	10666·7	12800·0	17066·7
48·5	2178·0	4356·0	6534·0	8712·0	10890·1	13068·1	17424·1
49·0	2223·1	4446·3	6669·4	8892·6	11115·7	13338·9	17785·2
49·5	2268·8	4537·5	6806·3	9075·0	11343·8	13612·5	18150·0
50·0	2314·8	4629·6	6944·4	9259·3	11574·1	13888·9	18518·5
50·5	2361·3	4722·6	7083·9	9445·2	11806·5	14167·8	18890·7
51·0	2408·3	4816·7	7225·0	9633·3	12041·7	14450·0	19266·7
51·5	2455·8	4911·6	7367·4	9823·2	12278·9	14734·7	19646·3
52·0	2503·7	5007·4	7511·1	10014·8	12518·5	15022·2	20029·6
52·5	2552·1	5104·2	7656·2	10208·3	12760·4	15312·5	20416·7
53·0	2600·9	5201·9	7801·8	10403·7	13004·6	15605·6	20807·4
53·5	2650·2	5300·5	7950·7	10600·9	13251·2	15901·4	21201·9
54·0	2700·0	5400·0	8100·0	10800·0	13500·0	16200·0	21600·0
54·5	2750·2	5500·5	8250·7	11000·9	13751·2	16501·4	22001·9

TABLE VII.—*continued.*

Depths in feet.	RATIO OF SLOPES.						
	¼ to 1.	½ to 1.	¾ to 1.	1 to 1.	1¼ to 1.	1½ to 1.	2 to 1.
55·0	2800·9	5601·9	8402·8	11203·7	14004·6	16805·6	22407·4
55·5	2852·1	5704·2	8556·2	11408·3	14260·4	17112·5	22816·7
56·0	2903·7	5807·4	8711·1	11614·8	14518·5	17422·2	23229·6
56·5	2955·8	5911·6	8867·4	11823·2	14778·9	17734·7	23646·3
57·0	3008·3	6016·7	9025·0	12033·3	15041·7	18050·0	24066·7
57·5	3061·3	6122·7	9184·0	12245·4	15306·7	18368·1	24490·7
58·0	3114·8	6229·6	9344·4	12459·3	15574·1	18688·9	24918·5
58·5	3168·7	6337·5	9506·2	12675·0	15843·7	19012·5	25350·0
59·0	3223·2	6446·3	9669·4	12892·6	16115·7	19338·9	25785·2
59·5	3278·0	6556·0	9834·0	13112·0	16390·1	19668·1	26224·1
60·0	3333·3	6666·7	10000·0	13333·3	16666·7	20000·0	26666·7
60·5	3389·1	6778·2	10167·4	13556·5	16945·6	20334·7	27113·0
61·0	3445·4	6890·7	10336·1	13781·5	17226·9	20672·2	27563·0
61·5	3502·1	7004·2	10506·3	14008·3	17510·4	21012·5	28016·7
62·0	3559·3	7118·5	10677·8	14237·0	17796·3	21355·6	28474·1
62·5	3616·9	7233·8	10850·7	14467·6	18084·5	21701·4	28935·2
63·0	3675·0	7350·0	11025·0	14700·0	18375·0	22050·0	29400·0
63·5	3733·6	7467·1	11200·7	14934·3	18667·8	22401·4	29868·5
64·0	3792·6	7585·2	11377·8	15170·4	18963·0	22755·6	30340·7
64·5	3852·1	7704·2	11556·3	15408·3	19260·4	23112·5	30816·7
65·0	3912·0	7824·1	11736·1	15648·2	19560·2	23472·2	31296·3
65·5	3972·5	7944·9	11917·4	15889·8	19862·3	23834·7	31779·6
66·0	4033·3	8066·7	12100·0	16133·3	20166·7	24200·0	32266·7
66·5	4094·7	8189·4	12284·0	16378·7	20473·4	24568·1	32757·4

67·0	4156·5	8313·0	12469·5	16625·9	20782·4	24938·9	33251·9
67·5	4218·8	8437·5	12656·3	16875·0	21093·8	25312·5	33750·0
68·0	4281·5	8563·0	12844·4	17125·9	21407·4	25688·9	34251·9
68·5	4344·7	8689·4	13034·0	17378·7	21723·4	26068·1	34757·4
69·0	4408·3	8816·7	13225·0	17633·3	22041·7	26450·0	35266·7
69·5	4472·5	8944·9	13417·4	17889·8	22362·3	26834·7	35779·7
70·0	4537·0	9074·1	13611·1	18148·2	22685·2	27222·2	36296·3
70·5	4602·1	9204·2	13806·3	18408·3	23010·4	27612·5	36816·7
71·0	4667·6	9335·2	14002·8	18670·4	23338·0	28005·6	37340·7
71·5	4738·6	9467·1	14205·7	18934·3	23672·8	28401·4	37868·5
72·0	4800·0	9600·0	14400·0	19200·0	24000·0	28800·0	38400·0
72·5	4866·9	9733·8	14600·7	19467·6	24334·5	29201·4	38935·2
73·0	4934·3	9868·5	14802·8	19737·0	24671·3	29605·6	39474·1
73·5	5002·1	10004·2	15006·3	20008·3	25010·4	30012·5	40016·7
74·0	5070·4	10140·7	15211·1	20281·5	25351·9	30422·2	40563·0
74·5	5139·1	10278·2	15417·4	20556·5	25695·6	30834·7	41113·0
75·0	5208·3	10416·6	15625·0	20833·3	26041·7	31250·0	41666·7
75·5	5278·0	10556·0	15834·0	21112·0	26390·1	31668·1	42224·1
76·0	5348·1	10696·3	16044·4	21392·6	26740·7	32088·9	42785·2
76·5	5418·8	10837·5	16256·3	21675·0	27093·8	32512·5	43350·0
77·0	5489·8	10979.6	16469·5	21959·3	27449·1	32938·9	43918·5
77·5	5561·4	11122·7	16684·0	22245·4	27806·7	33368·1	44490·7
78·0	5633·3	11266·7	16900·0	22533·3	28166·7	33800·0	45066·7
78·5	5705·8	11411·6	17117·4	22823·2	28528·9	34234·7	45646·3
79·0	5778·7	11557·4	17336·1	23114·8	28893·5	34672·2	46229·6
79·5	5852·1	11704·2	17556·3	23408·3	29260·4	35112·5	46816·7
80·0	5925·9	11851·9	17777·8	23703·7	29629·6	35555·6	47407·4

TABLE VIII.

GRADIENTS.

After laying down the gradients on a working section, we have to calculate the rise or fall chain by chain; on a line of only 10 miles in length this involves about 800 calculations, each of four or five figures, and as accuracy is imperative in this matter, the whole of the work has to be carefully checked. All those who have had to go through this operation, know the amount of labour it involves. It will be seen by a glance at Table VIII. that the work is there done ready to hand, and that by the use of it, the operation of checking the figures will be quite unnecessary. Every professional man knows also, that although the matter of calculating gradients for parliamentary sections is very simple, very serious mistakes often occur; probably from so much of this work being often done late in the night, when men are more than tired. The writer will just mention one case, which occurred not very long since. On an important line of about 20 miles in length, a clerical error of this description was carried through the section, and the consequence was that no further step was taken than to deposit the plans, for it was only afterwards, unfortunately, that the error was discovered. Not only about £2,000 in cash was lost in this matter, but the line of railway also. By a very simple use of this Table, and the application of a horizontal and a vertical scale, even the possibility of error is entirely avoided.

TABLE VIII.—Gradients for the 66 feet or 100 feet Chain.

RATIO.	RISE OR FALL IN FEET PER												
	Mile	Chain	5 chains	10 chains	20 chains	30 chains	Half-mile	100 feet	500 feet	1000 feet	2000 feet	3000 feet	4000 feet
one in													
25·0	211·2000	2·6400	13·2000	26·4000	58·8000	79·2000	105·6000	4·0000	20·0000	40·0000	80·0000	120·00 00	160·0000
25·5	207·0592	2·5882	12·9412	25·8824	51·7648	77·6472	103·5296	3·9216	19·6078	39·2157	78·4314	117·64 70	156·8627
26·0	203·0770	2·5385	12·6923	25·3846	50·7692	76·1538	101·5384	3·8461	19·2308	38·4615	76·9231	115·3846	153·8461
26·5	199·2453	2·4906	12·4528	24·9056	49·8113	74·7169	99·6226	3·7736	18·8679	37·7358	75·4717	113·2075	150·9434
27·0	195·5556	2·4444	12·2222	24·4444	48·8889	73·3333	97·7778	3·7037	18·5185	37·0370	74·0741	111·1111	148·1481
27·5	192·0000	2·4000	12·0000	24·0000	48·0000	72·0000	96·0000	3·6364	18·1818	36·3636	72·7273	109·0909	145·4545
28·0	188·5714	2·3559	11·7799	23·5589	47·1178	70·6767	94·2357	3·5714	17·8571	35·7143	71·4286	107·1428	142·8571
28·5	185·2632	2·3158	11·5789	23·1579	46·3158	69·4737	92·6316	3·5088	17·5439	35·0877	70·1754	105·2631	140·3509
29·0	182·0689	2·2759	11·3793	22·7586	45·5172	68·2759	91·0345	3·4483	17·2414	34·4827	68·9655	103·4483	137·9310
29·5	178·9830	2·2373	11·1864	22·3728	44·7457	67·1185	89·4915	3·3898	16·9492	33·8983	67·7966	101·6949	135·5932
30·0	176·0000	2·2000	11·0000	22·0000	44·0000	66·0000	88·0000	3·3333	16·6666	33·3333	66·6666	100·0000	133·3333
30·5	173·1147	2·1689	10·8447	21·6893	43·2787	64·9680	86·5574	3·2787	16·3934	32·7869	65·5738	98·3606	131·1475
31·0	170·3226	2·1290	10·6450	21·2901	42·5801	63·8702	85·1613	3·2259	16·1293	32·2586	64·5172	96·7758	129·0344
31·5	167·6191	2·0952	10·4762	20·9524	41·9048	62·8571	83·8095	3·1744	15·8722	31·7444	63·4888	95·2333	126·9777
32·0	165·0000	2·0625	10·3120	20·6250	41·2500	61·8750	82·5000	3·1250	15·6250	31·2500	62·5000	93·7500	125·0000
32·5	162·4615	2·0308	10·1538	20·3077	40·6154	60·9231	81·2308	3·0769	15·3846	30·7692	61·5385	92·3077	123·0769
33·0	160·0000	2·0000	10·0000	20·0000	40·0000	60·0000	80·0000	3·0303	15·1505	30·3030	60·6060	90·9091	121·2120
33·5	157·6119	1·9701	9·8507	19·7015	39·4030	59·1045	78·8060	2·9852	14·9262	29·8525	59·7049	89·5574	119·4098
34·0	155·2941	1·9412	9·7059	19·4118	38·8235	58·2353	77·6471	2·9412	14·7059	29·4118	58·8235	88·2353	117·6471
34·5	153·0435	1·9130	9·5652	19·1304	38·2609	57·3913	76·5217	2·8985	14·4927	28·9855	57·9710	86·9565	115·9710
35·0	150·8571	1·8857	9·4285	18·8570	37·7140	56·5710	75·4281	2·8571	14·2857	28·5714	57·1428	85·7143	114·2857
35·5	148·7324	1·8591	9·2958	18·5915	37·1831	55·7746	74·3662	2·8169	14·0845	28·1690	56·3380	84·5071	112·6761
36·0	146·6666	1·8333	9·1666	18·3333	36·6666	55·0000	73·3333	2·7777	13·8888	27·7777	55·5555	83·3333	111·1111
36·5	144·6575	1·8082	9·0421	18·0822	36·1644	54·2466	72·3288	2·7336	13·6678	27·3356	54·6712	82·0068	109·3425

37·0	142·7027	1·7838	8·9189	17·8378	35·6757	53·5135	71·3513	2·7027	13·5135	27·0270	54·0540	81·0810	108·1081
37·5	140·8000	1·7600	8·8000	17·6000	35·2000	52·8000	70·4000	2·6666	13·3333	26·6666	53·3333	80·0000	106·6666
38·0	138·9474	1·7368	8·6842	17·3684	34·7368	52·1053	69·4737	2·6316	13·1579	26·3158	52·6316	78·9474	105·2632
38·5	137·1429	1·7143	8·5714	17·1428	34·2857	51·4286	68·5714	2·5974	12·9870	25·9740	51·9480	77·9220	103·8961
39·0	135·3846	1·6923	8·4615	16·9230	33·8461	50·7693	67·6923	2·5641	12·8205	25·6410	51·2820	76·9230	102·5641
39·5	133·6709	1·6709	8·3544	16·7089	33·4177	50·1266	66·8354	2·5316	12·6582	25·3164	50·6329	75·9494	101·2658
40·0	132·0000	1·6500	8·25000	16·5000	33·0000	49·5000	66·0000	2·5000	12·5000	25·0000	50·0000	75·0000	100·0000
40·5	130·3704	1·6296	8·1481	16·2963	32·5926	48·8888	65·1852	2·4691	12·3457	24·6914	49·3827	74·0741	98·7654
41·0	128·7805	1·6098	8·0488	16·0976	32·1952	48·2928	64·3902	2·4390	12·1951	24·3902	48·7805	73·1707	97·5610
41·5	127·2289	1·5904	7·9518	15·9036	31·8072	47·7108	63·6144	2·4096	12·0482	24·0964	48·1928	72·2891	96·3855
42·0	125·7143	1·5714	7·8571	15·7143	31·4286	47·1428	62·8571	2·3810	11·9048	23·8095	47·6190	71·4286	95·2381
42·5	124·2353	1·5529	7·7647	15·5294	31·0588	46·5882	62·1176	2·3529	11·7647	23·5294	47·0588	70·5882	94·1176
43·0	122·7907	1·5349	7·6744	15·3488	30·6977	46·0465	61·3953	2·3256	11·6279	23·2558	46·5116	69·7674	93·0232
43·5	121·3793	1·5172	7·5862	15·1724	30·3448	45·5172	60·6896	2·2989	11·4943	22·9885	45·9770	68·9655	91·9540
44·0	120·0000	1·5000	7·5000	15·0000	30·0000	45·0000	60·0000	2·2727	11·3636	22·7273	45·4545	68·1818	90·9091
44·5	118·6517	1·4831	7·4157	14·8315	29·6629	44·4943	59·3258	2·2472	11·2360	22·4719	44·9438	67·4157	89·8876
45·0	117·3333	1·4667	7·3333	14·6667	29·3333	44·0000	58·6666	2·2222	11·1111	22·2222	44·4444	66·6667	88·8889
45·5	116·0439	1·4505	7·2526	14·5052	29·0104	43·5156	58·0219	2·1979	10·9896	21·9792	43·9583	65·9375	87·9166
46·0	114·7826	1·4348	7·1739	14·3478	28·6956	43·0434	57·3913	2·1738	10·8692	21·7384	43·4767	65·2151	86·9535
46·5	113·5484	1·4194	7·0968	14·1935	28·3870	42·5805	56·7742	2·1505	10·7527	21·5054	43·0108	64·5161	86·0215
47·0	112·3403	1·4043	7·0213	14·0426	28·0851	42·1277	56·1701	2·1277	10·6383	21·2766	42·5531	63·8297	85·1062
47·5	111·1589	1·3895	6·9474	13·8947	27·7894	41·6841	55·5789	2·1053	10·5263	21·0526	42·1053	63·1579	84·2105
48·0	110·0000	1·3750	6·8750	13·7500	27·5000	41·2500	55·0000	2·0833	10·4167	20·8333	41·6667	62·5000	83·3333
48·5	108·8659	1·3608	6·8041	13·6082	27·2164	40·8246	54·4329	2·0619	10·3093	20·6186	41·2371	61·8557	82·4742
49·0	107·7551	1·3469	6·7347	13·4694	26·9388	40·4082	53·8775	2·0408	10·2041	20·4082	40·8163	61·2245	81·6326
49·5	106·6666	1·3333	6·6667	13·3333	26·6667	40·0000	53·3333	2·0202	10·1010	20·2020	40·4040	60·6060	80·8080
50·0	105·6000	1·3200	6·6000	13·2000	26·4000	39·6000	52·8000	2·0000	10·0000	20·0000	40·0000	60·0000	80·0000
51·0	103·5294	1·2941	6·4706	12·9412	25·8824	38·8235	51·7647	1·9608	9·8039	19·6078	39·2157	58·8235	78·4314
52·0	101·5385	1·2692	6·3461	12·6923	25·3846	38·0769	50·7692	1·9231	9·6154	19·2307	38·4615	57·6923	76·8462
53·0	99·6226	1·2453	6·2264	12·4528	24·9057	37·3585	49·8113	1·8868	9·4340	18·8679	37·7358	56·6038	75·4717

TABLE VIII.—*continued.*

RATIO	RISE OR FALL IN FEET PER												
	Mile	Chain	5 chains	10 chains	20 chains	30 chains	Half-mile	100 feet	500 feet	1000 feet	2000 feet	3000 feet	4000 feet
one in													
54·0	97·7778	1·2222	6·1111	12·2222	24·4444	36·6667	48·8889	1·8519	9·2593	18·5185	37·0370	55·5556	74·0741
55·0	96·0000	1·2000	6·0000	12·0000	24·0000	36·0000	48·0000	1·8182	9·0909	18·1818	36·3636	54·5454	72·7272
56·0	94·2857	1·1786	5·8929	11·7857	23·5714	35·3571	47·1429	1·7857	8·9285	17·8571	35·7141	53·5712	71·4282
57·0	92·6315	1·1579	5·7895	11·5790	23·1579	34·7369	46·3158	1·7544	8·7719	17·5439	35·0877	52·6316	70·1754
58·0	91·0345	1·1379	5·6897	11·3793	22·7586	34·1379	45·5172	1·7241	8·6207	17·2414	34·4829	51·7243	68·9658
59·0	89·4915	1·1186	5·5932	11·1864	22·3729	33·5593	44·7458	1·6949	8·4746	16·9492	33·8983	50·8475	67·7966
60·0	88·0000	1·1000	5·5000	11·0000	22·0000	33·0000	44·0000	1·6667	8·3333	16·6667	33·3333	50·0000	66·6667
61·0	86·5574	1·0819	5·4098	10·8197	21·6393	32·4590	43·2787	1·6393	8·1967	16·3934	32·7869	49·1803	65·5738
62·0	85·1613	1·0645	5·3226	10·6452	21·2903	31·9355	42·5806	1·6129	8·0645	16·1290	32·2581	48·3871	64·5161
63·0	83·8095	1·0476	5·2381	10·4762	20·9524	31·4286	41·9047	1·5873	7·9365	15·8730	31·7460	47·6190	63·4920
64·0	82·5000	1·0313	5·1563	10·3125	20·6250	30·9375	41·2500	1·5625	7·8125	15·6250	31·2500	46·8750	62·5000
65·0	81·2308	1·0154	5·0769	10·1539	20·3077	30·4615	40·6154	1·5385	7·6923	15·3846	30·7692	46·1538	61·5385
66·0	80·0000	1·0000	5·0000	10·0000	20·0000	30·0000	40·0000	1·5152	7·5757	15·1515	30·3030	46·4545	60·6061
67·0	78·8060	0·9857	4·9287	9·8575	19·7149	29·5724	39·4030	1·4925	7·4627	14·9254	29·8507	44·7761	59·7015
68·0	77·6470	0·9706	4·8529	9·7059	19·4118	29·1176	38·8235	1·4706	7·3529	14·7059	29·4118	44·1176	58·8235
69·0	76·5222	0·9565	4·7826	9·5652	19·1304	28·6957	38·261	1·4493	7·2464	14·4928	28·9855	43·4783	57·9710
70·0	75·4886	0·9429	4·7143	9·4286	18·8571	28·2857	37·7143	1·4286	7·1429	14·2857	28·5714	42·8571	57·1528
71·0	74·3662	0·9296	4·6479	9·2958	18·5916	27·8873	37·1831	1·4085	7·0423	14·0845	28·1690	42·2535	56·3378
72·0	73·3333	0·9167	4·5833	9·1667	18·3333	27·5000	36·6667	1·3889	6·9444	13·8889	27·7778	41·6667	55·5556
73·0	72·3298	0·9041	4·5205	9·0411	18·0822	27·1233	36·1644	1·3699	6·8493	13·6986	27·3973	41·0959	54·7946
74·0	71·3513	0·8919	4·4595	8·9189	17·8378	26·7568	35·6757	1·3514	6·7568	13·5135	27·0270	40·5405	54·0540
75·0	70·4000	0·8800	4·4000	8·8000	17·6000	26·4000	35·2000	1·3333	6·6667	13·3333	26·6667	40·0000	53·3333
76·0	69·473	0·8684	4·3421	8·6842	17·3684	26·0526	34·7368	1·3158	6·5789	13·1579	26·3158	39·4737	52·6316
77·0	68·5714	0·8571	4·2857	8·5714	17·1429	25·7143	34·2857	1·2987	6·4935	12·987	25·9740	38·9610	51·9480

78·0	67·692	0·8462	4·2308	8·4615	16·9231	25·3846	33·8462	1·2820	6·4100	12·8201	25 6402	38·4604	51·2820
79·0	66·8354	0·8354	4·1772	8·3544	16·7088	25·0633	33·4177	1·2658	6·3291	12·6582	25·3164	37·9747	50·6329
80·0	66·000	0·8250	4·1250	8·2500	16·5000	24·7500	33·0000	1·2500	6·2500	12·5000	25·0000	37·5000	50·0000
81·0	65·1851	0·8148	4·0741	8·1481	16·2963	24·4444	32·5925	1·2345	6·1728	12·3457	24·6914	37·0470	49·3827
82·0	64·3904	0·8049	4·0244	8·0488	16·0976	24·1464	32·1952	1·2195	6·0976	12·1951	24·3902	36·5854	48·7804
83·0	63·6154	0·7952	3·9759	7·9518	15·9036	23·8554	31·8072	1·2048	6·0241	12·0482	24·0964	36·1446	48·1928
84·0	62·8570	0·7857	3·9286	7·8571	15·7143	23·5714	31·4285	1·1905	5·9524	11·9047	23·8095	35·7143	47·6190
85·0	62·1176	0·7765	3·8824	7·7647	15·5294	23·2941	31·0588	1·1764	5·8821	11·7647	23·5294	35·2941	47·0588
86·0	61·3954	0·7674	3·8372	7·6744	15·3488	23·0232	30·6977	1·1625	5·8125	11·6251	23·2501	34·8752	46·5116
87·0	60·6896	0·7586	3·7931	7·5862	15·1724	22·7586	30·3448	1·1494	5·7471	11·4942	22·9885	34·4828	45·9770
88·0	60·0000	0·7500	3·7500	7·5000	15·0000	22·5000	30·0000	1·1364	5·6818	11·3636	22·7273	34·0908	45·4545
89·0	59·3262	0·7416	3·7079	7·4158	14·8316	22·2473	29·6631	1·1238	5·6190	11·2385	22·4769	33·7154	44·9539
90·0	58·6667	0·7333	3·6667	7·3333	14·6667	22·0000	29·3333	1·1111	5·5555	11·1111	22·2222	33·3333	44·4444
91·0	58·022	0·7253	3·6263	7·2526	14·5052	21·7578	29·011	1·0989	5·4948	10·9890	21·9780	32·9670	43·9560
92·0	57·391	0·7174	3·5870	7·1739	14·3478	21·5217	28·6956	1·0869	5·4346	10·8692	21·7384	32·6076	43·4782
93·0	56·774	0·7097	3·5484	7·0968	14·1935	21·2903	28·3870	1·0753	5·3763	10·7527	21·5054	32·2581	43·0108
94·0	56·170	0·7021	3·5106	7·0213	14·0426	21·0638	28·085	1·0638	5·3191	10·6383	21·2766	31·9148	42·5532
95·0	55·579	0·6948	3·4739	6·9479	13·8957	20·8436	27·789	1·0526	5·2632	10·5263	21·0526	31·5789	42·1053
96·0	55·000	0·6875	3·4375	6·8750	13·7500	20·6250	27·500	1·0417	5·2083	10·4167	20·8333	31·25000	41·6666
97·0	54·433	0·6804	3·4021	6·8041	13·6082	20·4123	27·217	1·0309	5·1546	10·3093	20·6186	30·9278	41·2371
98·0	53·878	0·6735	3·3672	6·7347	13·4694	20·2041	26·939	1·0204	5·1020	10·2041	20·4082	30·6122	40·8161
99·0	53·333	0·6667	3·3333	6·6667	13·3333	20·000	26·667	1·0101	5·0505	10·1010	20·2020	30·3030	40·4040
100·0	52·800	0·6600	3·3000	6·6000	13·2000	19·8000	26·400	1·0000	5·0000	10·0000	20·0000	30·0000	40·0000
101·0	52·2772	0·6535	3·2673	6·5347	13·0693	19·6040	26·1386	0·9901	4·9505	9·9010	19·8020	29·7030	39·6037
102·0	51·7647	0·6470	3·2353	6·4706	12·9412	19·9113	25·8823	0·9804	4·9019	9·8039	19·6078	29·4117	39·2147
103·0	51·2621	0·6408	3·2039	6·4078	12·8155	19·2233	25·6311	0·9709	4·8544	9·7087	19·4175	29·1262	38·8349
104·0	50·7692	0·6346	3·1731	6·3461	12·6923	19·0385	25·3846	0·9615	4·8077	9·6153	19·2308	28·8461	38·4615
105·0	50·2857	0·6285	3·1429	6·2857	12·5714	18·8571	25·1428	0·9524	4·7619	9·5238	19·0476	28·5714	38·0952
106 0	49·8113	0·6226	3·1132	6·2264	12·4528	18·6792	24·9056	0·9434	4·7170	9·4340	18·8680	28·3020	37·7358
107·0	49·3458	0·6168	3·0841	6·1682	12·3364	18·5047	24·6729	0·9346	4·6729	9·3458	18·6916	28·0374	37·3831

TABLE VIII.—*continued.*

RATIO	RISE OR FALL IN FEET PER												
	Mile	Chain	5 chains	10 chains	20 chains	30 chains	Half-mile	100 feet	500 feet	1000 feet	2000 feet	3000 feet	4000 feet
one in 108·0	48·8889	0·61111	3·0556	6·1111	12·2222	18·3333	24·4444	0·9259	4·6296	9·2593	18·5185	27·7778	37·0370
109·0	48·4404	0·6055	3·0275	6·0550	12·1101	18·1651	24·2202	0·9174	4·5872	9·1743	18·3486	27·5229	36·6972
110·0	48·0000	0·6000	3·0000	6·0000	12·0000	18·0000	24·0000	0·9091	4·5455	9·0909	18·1818	27·2727	36·3636
115·0	45·9130	0·5739	2·8696	5·7391	11·4783	17·2174	22·9562	0·8696	4·3478	8·6957	17·3913	26·0870	34·7826
120·0	44·0000	0·5500	2·7500	5·5000	11·0000	16·5000	22·0000	0·8333	4·1667	8·3333	16·6667	25·0000	33·3333
125·0	42·2400	0·5280	2·6400	5·2800	10·5600	15·8400	21·1200	0·8000	4·0000	8·0000	16·0000	24·0000	32·0000
130·0	40·6154	0·5077	2·5385	5·0769	10·1538	15·2307	20·3077	0·7692	3·8462	7·6923	15·3846	23·0769	30·7692
135·0	39·1111	0·4889	2·4444	4·8889	9·7778	14·6667	19·5556	0·7407	3·7037	7·4074	14·8148	22·2221	29·6295
140·0	37·7143	0·4714	2·3571	4·7143	9·4286	14·1428	18·8571	0·7143	3·5714	7·1429	14·2857	21·4286	28·5714
145·0	36·4138	0·4552	2·2759	4·5517	9·1034	13·6552	18·2069	0·6897	3·4483	6·8966	13·7931	20·6897	27·5862
150·0	35·2000	0·4400	2·2000	4·4000	8·8000	13·2000	17·6000	0·6667	3·3333	6·6667	13·3333	20·0000	26·6667
155·0	34·0645	0·4258	2·1290	4·2581	8·5163	12·7745	17·0323	0·6452	3·2258	6·4516	12·9032	19·3548	25·8064
160·0	33·0000	0·4125	2·0625	4·1250	8·2500	12·3750	16·5000	0·6250	3·1250	6·2500	12·5000	18·7500	25·0000
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